REPORT RESUMES

ED 016 047 VT 001 420
THE PRE-TECHNOLOGY PROGRAM, A DESCRIPTIVE REPORT.
BY- SMITH, GARRISON B. AND OTHERS
COGSWELL POLYTECHNICAL COLL., SAN FRANCISCO, CALIF
PUB DATE 66
EDRS PRICE MF-$0.50 HC-$3.52 86P.

DESCRIPTORS- *TEAM TEACHING, CURRICULUM DEVELOPMENT, INDUSTRIAL ARTS, JOB SKILLS, ENGINEERING TECHNICIANS, TECHNICAL EDUCATION, PROGRAM DESCRIPTIONS, *CURRICULUM, *BEHAVIORAL OBJECTIVES, ENGLISH, GRADE 11, GRADE 12, SCIENCES, TECHNICAL MATHEMATICS, *PREVOCATIONAL EDUCATION, RICHMOND PLAN,

AFTER DEMONSTRATED SUCCESS IN THE RICHMOND, CALIFORNIA SCHOOLS, THE PRETECHNOLOGY PROGRAM WAS EXTENDED TO 10 HIGH SCHOOLS IN THE SAN FRANCISCO BAY AREA. THE MAJOR THESIS OF THE PROGRAM IS THAT THE TECHNOLOGICAL REVOLUTION WILL REQUIRE A MAJOR PORTION OF AVERAGE HIGH SCHOOL STUDENTS TO CONTINUE THEIR EDUCATION BEYOND HIGH SCHOOL. THE PROGRAM WAS DESIGNED TO ORIENT THE "CAPABLE AVERAGE" LEARNER TO SEMIPROFESSIONAL PROGRAMS IN JUNIOR COLLEGES OR TECHNICAL INSTITUTES AND TO THE JOB OF ENGINEERING TECHNICIAN AT VARIOUS LEVELS. IT CONSISTS OF A 2-YEAR PREENGINEERING TECHNOLOGY SEQUENCE OF FOUR INTEGRATED AND CORRELATED COURSES BEGINNING IN GRADE 11. THE COURSES, ENGLISH, SCIENCE, MATHEMATICS, AND TECHNICAL-LABORATORY, ARE TAUGHT BY A TEAM OF TEACHERS WHO UTILIZE THE NATURAL RELATIONSHIPS AMONG THE SUBJECTS. THE PROGRAM CONCERNS ITSELF WITH FIVE RESPONSIBILITIES TO THE STUDENT--ABILITY ASSESSMENT, JOB INFORMATION, PROGRAMS OF OCCUPATIONAL INTEREST, LEVEL OF INSTRUCTION, AND QUALITY OF THE PROGRAM. THE CURRICULUM WAS DEVELOPED BY DESCRIBING THE ENGINEERING TECHNICIAN, STATING THE OBJECTIVES IN BEHAVIORAL AND MEASURABLE TERMS, ANALYZING GENERAL AND SPECIFIC SKILLS AND KNOWLEDGE NEEDED, AND CORRELATING THE RESULTS INTO SUBJECT AREAS. ALTHOUGH COOPERATING SCHOOLS WERE IN CLOSE AGREEMENT REGARDING THE FACTS AND SKILLS REQUIRED, THEY DIFFERED IN TEACHING METHODS. A CURRICULUM OUTLINE FOR 1 YEAR'S WORK, A SINGLE UNIT, AND THE LEARNING ACTIVITIES OF A SINGLE UNIT, EACH FROM A DIFFERENT SCHOOL, ARE GIVEN. (EM)

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ED016047

COGSWELL POLYTECHNICAL COLLEGE
San Francisco, California

THE PRE-TECHNOLOGY PROGRAM

A Descriptive Report

Submitted in Partial Satisfaction
of
The Terms of The Grant
from
The Ford Foundation

VT 01420

Project Staff

Marvin J. Feldman
Director 1963-1964

Garrison B. Smith
Associate Director 1963-1964
Director 1964-1966

Peter S. Grimes
Associate Director 1964-1965

Mrs. Olga Gaevert
Secretary 1963-1966

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THE PRE-TECHNOLOGY PROGRAM

Foreword:

The Pre-Technology Program is a major re-evaluation of the principles and practices in high school programs designed to meet the specialized needs of capable "average" high school students in terms of continuing education.

It is a major thesis of the Pre-Tech Program that the technological revolution will require the major portion of our "average" students to continue their education beyond high school. This educational revolution can be greatly facilitated by high school programs which are able to motivate the students toward scholastic success. Such motivation is achieved in the Pre-Tech Program by basing the curriculum upon realistic needs and modern instructional methods.

This particular project has an engineering technology orientation because of its boy appeal and proven need in our economy. The goal of the program is to send pre-tech graduates to local community colleges (junior colleges) and technical institutes where they will major in semi-professional technical curricula. It is hoped they will graduate in two years as technicians in any of a variety of fields.

Certainly, other pre-tech "orientations" are possible and desirable. However, it is the purpose of this program to prove the feasibility of the idea, not to explore all its possible applications and ramifications. The following pages will trace the development and trial of engineering type pre-tech programs and leave to other creative individuals various adaptations of the pre-tech process.

The successful introduction of a pre-technology high school curriculum into San Francisco Bay Area high schools was originally made possible by a grant from the Rosenberg Foundation of San Francisco to Cogswell Polytechnical College and, later, to the Richmond City Schools, California. During this phase the Program was known as The Richmond Plan.

Following the demonstrated success of the pre-technology curriculum in the Richmond Schools, The Ford Foundation made a grant to Cogswell for the purpose of broadening the base of the pre-tech concept. Operating under the support of The Ford Foundation since the summer of 1963, the Pre-Technology Program has involved ten high schools in eight high school districts of the San Francisco Bay Area.

This report of The Pre-Technology Program represents a summary of the philosophy of the Project, a description of the process of curriculum development used, and a review of the teaching methods employed.

Pre-Technology Program Office
Cogswell Polytechnical College
of San Francisco
Fall, 1966

Preface:

In the period following World War II, surging currents of change have swept through the nation's high schools, colleges, and universities. Advanced American technology, automation, and emphasis in secondary education upon university preparation in the liberal arts have combined to create a serious shortage of trained technicians at the very time our country is facing a severe unemployment problem among its youth. Indeed, the repetition of pronouncements on the matter has probably dulled our sensibilities to it.

A major social problem exists in the United States because of a steady decline in the number of available unskilled jobs and a steady increase in the number of unskilled high school graduates. Approximately one million American high school graduates annually enter the job market unprepared for anything but unskilled labor. During this decade some twenty-six million young persons will enter the nation's job market for the first time! Of this number a minimum of 30% will most probably be under educated for the employment available and will experience great difficulty in becoming part of the labor force. It is estimated that only one student in ten leaving school without a bachelor's degree has some specific occupational preparation.

The paradox of increasing numbers of job opportunities of a technical nature coupled with accelerating unemployment of unskilled workers is not a product of any single factor, but a combination of factors, namely: increasing automation in industry, business, and agriculture; the increasingly technical aspects of all kinds of work requiring considerably higher levels of educational competence than past standards; and the increasing speed with which homes and schools must adapt to the rapidly changing social climate engendered by technological change.

The Pre-Technology Program reflects a marked change in attitudes towards public school education in the United States during the post-war years. These new attitudes have led to an intensification of efforts to tailor educational programs to the individual student, rather than continuing the futile practice of molding the student to the curricula available. With the knowledge that school curricula must respond more rapidly to the increasingly frequent and perplexing changes in society, local leaders in business, industry, and education have combined in a spirit of joint responsibility and cooperation to produce the Pre-Tech concept.

The program is a pre-engineering technology course of study for the "capable average" learner. It is a conservation program designed to offer a socially acceptable alternative to marginal students in traditional college education by providing the learner with a curriculum commensurate with his real, rather than supposed, abilities and occupational needs. It is a program designed to motivate for success using teaching methods founded upon knowledge of the learning processes.

The Pre-Technology Program is not a curriculum development project per se. Rather, it provides for a structure within the high school which facilitates the development, by teachers, of a local curriculum, and which encourages the use of efficient student-teacher learning techniques. The program is a framework which a local school or school system may adapt to its own individual needs according to today's best educational standards.

It has been pointed out by many responsible professionals that a standard curriculum would greatly accelerate the spread of this type of technical-vocational high school education throughout the country. The program has not attempted to do this, demonstrating instead that many of our urban and suburban schools are perfectly capable of developing their own curricula once the teachers are imbued with the Pre-Tech philosophy and trained in Pre-Tech curriculum development processes and teaching methods. This does not diminish the value of published curricula; strong forces are already at play to insure their preparation. The program has purposefully avoided a "lockstep" curriculum, so that local schools could react independently to the unique educational needs of their own community.

The Pre-Tech Program focuses on pre-engineering technology for a number of reasons. The concept germinated in Cogswell Polytechnical College, San Francisco, an engineering technical institute, although it was conceived through an exchange of ideas between many individuals and institutions. It was thought that the engineering emphasis would provide a greater chance for success because of its appeal to young men and because of the known national need for engineering technicians. It was also realized that the penetration of experimental concepts into current educational practice is often best achieved by concentrating one's resources. Many of the ideas upon which the program is based had been explored for years by technical institutes throughout the United States, and Cogswell had always taken a leading role in these developments.

Nevertheless, from its inception the program was considered in the context of general education. We are living in a rapidly changing economy which requires an individual to be flexibly informed and educated so that changes in job opportunities will not usurp an individual's right to a place in society. The important things that permit one to transfer from one field to another are his ability to think logically, to examine in a mathematical way, to speak, to write, and to express himself in a manner that permits him to succeed at different jobs. Pre-Tech curricula are based upon these truisms.

The pages which follow represent a synthesis of the attitudes and opinions of all associated with the program, but particularly of the teachers at the action end of the project.

The program does not represent a research effort as the term is normally understood, except that this report is a canvas of men's minds and their educational activities relating to this program. It is an action program based upon a concept whose validity must necessarily rest upon the educational and vocational success of its students, and upon its acceptance by the educational community.

The program claims no general remedy for all educational ills. It is an attack on part of the problem in a particular area of interest. No small part of its modest success to date stems from the "do something" attitude of all the participants. Already the idea has proved infectious! It is hoped that the following pages will be of assistance to other schools in implementing their action programs for average youth.

History:

For years, the officials of Cogswell Polytechnical College had been aware of the increasing need for semi-professional technical manpower in an increasingly technological economy. It was their experience that a large number of Cogswell students had required considerable remedial schooling in high school subjects, taking up to three or more college years to complete a two-year program in engineering technology. Study of the situation revealed that those students requiring remedial attention had invariably wasted much of their time in high school by enrolling in courses and course sequences unsuited, in one way or another, to their interests, needs, and abilities.

In its contacts with local high schools Cogswell naturally expressed the desire that something be done in the high schools to help these students. This resulted in a working relationship with several high schools from which the pre-technology concept evolved. Traditionally, the high school offered two basic programs for its students: terminal and college preparatory. The Cogswell group proposed a third track, intermediate between the two established tracks,occupationally oriented but preparatory to two-year junior college or technical institute semi-professional programs.

Several years ago Cogswell, in cooperation with the Richmond High School District in Richmond, California, explored the possibility of motivating and preparing high school students for semi-professional technical education using curriculum and methodology guidelines developed over the past few decades in technical institutes throughout the United States. Their hope was to establish a third high school track which would provide a suitable alternative to the two existing curricula. It was felt that there was a large enough reservoir of students who could profit educationally from such a program to justify an intensive exploration of the idea.

With a grant in 1961 from San Francisco's Rosenberg Foundation, pre-technological education for high school students was launched. Workshops with the Richmond teachers were held at Cogswell during the summers of 1961 and 1962 and the intervening school year. Preliminary plans were laid during this period, with the start of instruction scheduled for the fall of 1962. Because of the geographical location, the program was initially known as the Richmond Plan.

In essence, the Richmond Plan was designed to offer high school students an interdisciplinary pre-engineering technology curriculum leading to enrollment in engineering technology programs offered by technical institutes and junior colleges.

In 1963, The Ford Foundation awarded $185,000 to Cogswell to broaden the base of the pilot program. During that summer, teaching teams in five other San Francisco Bay Area high schools developed pre-technology programs for their own schools. Instruction in these schools commenced in September, 1963. Three more high schools were added to the Pre-Technology Program during the summer of 1964.

Cogswell's participation in the Pre-Technology Program terminated during the summer of 1966 as the last three schools to join the program graduated their first Pre-Tech class.

A Brief Description:

The Pre-Technology Program consists of a two-year pre-engineering technology sequence of four integrated and correlated courses beginning in the eleventh grade. These courses are: English, physics and chemistry, mathematics through trigonometry, and technical laboratory. The Pre-Tech students take these subjects as a group, mixing with the student body for the other courses required in the eleventh and twelfth grades (history, government, and physical education).

The Program is characterized by team teaching, a unique curriculum, a modern synthesis of efficient instructional techniques, and a new orientation toward college.

The teaching team consists of four teachers: English, science, mathematics, and tech-lab. Each member well qualified in his respective discipline, the team develops the curriculum on the school site during two consecutive summer workshops. During the school year they hold several joint conferences each week to review progress and coordinate future lessons. The teams are especially trained during the first summer workshop to develop pre-tech curricula and to work with pre-tech students.

In developing the curriculum the natural relationship of each subject to the others is drawn out and used for constant reinforcement. For example, the study of heat taught in science is related in mathematics to first degree equations, supported by the construction of apparatus in tech-lab to conduct experiments, and followed in the English class by oral and written reports on this subject. No attempt is made to create artificial content. The interrelationships between the subjects are taught as an addition to the objectives of the courses themselves. The course objectives are based upon the goals of the program and the consequent needs of the students.

The technical laboratory is an integrated shop program that is not intended to train craftsmen. Manipulative skills and familiarity with tools and materials gained here enable students to apply the theoretical knowledge covered in other courses. This helps them see the relationship between theory and practice. As a by-product, they learn to handle the basic tools and equipment they will use when employed.

The instructional techniques employed are well known. In general, they are applications of established principles in learning theory. Paramount among these is the Pre-Tech requirement that instructional objectives be specific, be couched in terms of behavioral changes expected of the student, be distributed to the student before instruction begins, and form the basis for evaluation after instruction is completed.

The program uses occupational interest (engineering technology) as a motivating force behind a sound educational program. But this orientation does not lead to an educational dead end. The program does not lose sight of the fact that acquiring the ability to learn throughout one's life is rapidly becoming the most valuable asset of any worker.

In particular, the program can in no way be considered a "watered down" curriculum. It is a program designed for a specific purpose. Its curriculum is solidly wedded to its goals. Having a semi-professional rather than a professional (university) orientation, the program naturally places less emphasis upon theoretical and highly abstract concepts. Nevertheless, the student's cognitive abilities are severely taxed. High quality student performance, corresponding to his potential, is expected and required.

The goal of the program is to enhance the school success of the participating students and to prepare them for curricula of a technical nature in junior colleges, community colleges, or technical institutes. By stressing education over training, this goal can be achieved by the majority of students and still allow the exceptionally competent to complete the final two years of college study.

The Pre-Technology Program is Quality General Education.

In spite of the engineering technology orientation, the Pre-Tech Program has deliberately been kept generalized, in order to provide all participating students a service regardless of their post-high school plans. The Pre-Tech English, science, and mathematics backgrounds are qualifying for any junior college program and for many college majors depending upon the student's level of scholarship.

The entire Pre-Tech Program is based upon the concept that many marginal, traditional college preparatory students can be very successful in learning situations designed to accommodate their interests and abilities. Further, it is believed that this can be done with no loss of quality. There is every indication that the program represents an increase of educational quality for the students involved.

Adapting a course to the needs and interests of a small group of students does not necessarily affect its value as general education. The program emphasizes education as opposed to training so that the student will acquire lifelong learning habits so vitally necessary in this day of rapid obsolescence of specific knowledge and skills. The program does not require that the student make a specific vocational decision at high school, a characteristic of most vocational type programs. Rather, the student chooses an area of interest.

The Pre-Tech Program is acutely aware that the student must prepare for jobs in the future which do not exist today. When a job ceases to exist, the trained individual must look for a new job requiring a minimum of retraining and new knowledge. These jobs are difficult to find. On the other hand, the educated person, after a short period of training, is qualified for many different types of work and has more empl-yment opportunities.

Some may think that a technical program will tend to be overspecialized. This is a myth. Even in highly specialized technical programs the student spends a major portion of his time studying the basic subjects: mathematics, science, and communication. These fundamental skills have become as occupationally important as the manual skills were a few generations ago.

Those of us accustomed to traditional education and yesterday's vocations must adopt a new point of view. Technical education in the "new" technological society is different. Profound changes have taken place in a relatively few years until, it now seems, the purposes of general education and of technical-vocational education are rapidly converging. They represent two points of view toward accomplishing the same thing. The Pre-Tech English teacher, for example, may use the technical report instead of the narrative essay as the most appropriate vehicle to accomplish her purposes. However, this does not mean that she must also ignore the cultural aspects of our language. In fact, we would like to think that the inclusion of technology into the cultural portion of any high school English program has validity for all students, traditional or Pre-Tech.

In practicing general education, we must also accommodate individual needs. Their exclusion makes a travesty of the goals of contemporary schooling. The humanities should cover all aspects of human creativity. The Pre-Tech Program should keep its cultural house in order, just as the more traditional college prep programs are expected to respect the totality of man's experiences including the technological arts.

The Pre-Technology School Program is a Consequence of the Technological Revolution.

A long, continuing trend in the United States has been to require two or more years of college for an ever increasing percentage of jobs. This development, representing a radical change in occupations since the end of World War II, is recognition of the fact that our increasingly technical society requires larger numbers of college educated technical assistants and a general upgrading of the educational preparation for all jobs.

The really dramatic change in jobs has been the creation of new types of work, mostly technical, which simply did not exist a generation ago. The computer programer is an outstanding example of an occupation which, for all practical purposes, did not exist ten years ago, and which now employs tens of thousands of persons. Paralleling this is the rapid disappearance of many manual jobs due to automation. Even the modern "ditch digger" operates a machine, not a shovel, and must have far more technical competence than his counterpart of a generation ago.

As a direct result of technological change, the largest increase in new jobs is occurring in occupations that require the most education and training. Jobs are becoming more and more cognitive and less and less physical. The new worker is expected to think and be able to communicate the results of his thinking. Even the armed forces are offering fewer and fewer opportunities to the undereducated. The fact of the matter is that business and industry today have little place for the worker without a definite skill.

There is little room at the bottom, more room at the top. In the new technology, job entry and upgrading are increasingly a matter of educational preparation. More and more of what is basic to successful performance in today's occupations is best taught in educational institutions. In the same way apprenticeship gave way to professional education in medicine, law, and engineering, so on-the-job technical training and apprenticeship are giving way to occupational and technical education in our schools.

Students who do not pursue occupational goals in school, and who are able to find work, usually end up in the low or unskilled, low-paying jobs--jobs without security and without future, jobs frustratingly below the worker's potential.

Automation and computerization are in the dramatic foreground of technical change in America. Automation encompasses a class of devices that automatically perform sensing and motor tasks formerly done by human labor. Computers are devices which rapidly perform traditional human tasks involving experience, memory, analysis, logic, and decision-making. Automatic devices and computerized controls have obviated the need for manual labor in manufacture, at the same time creating an army of designers, operators, maintenance workers, programers, etc. These new jobs are mental rather than physical, requiring more and better school preparation. They are the jobs of today!

This is the society which, in the minds of the creators of the Pre-Tech concept, demanded a third-track high school curriculum--a curriculum occupationally oriented, but educationally valid for the newly created technical jobs. Such a curriculum would logically be intermediate between the traditional vocational and college preparatory tracks, and would provide a unique opportunity to utilize fully modern and efficient motivational instructional techniques.

The engineering emphasis for this high school pretechnology curriculum came about largely because the idea originated with engineering-technology educators who became aware of the technological demands upon public education at an early date. The inclusion of such a program in comprehensive high schools was justified on the grounds that a pre-engineering technology (not pre-engineering) curriculum would be basic to a broad spectrum of professional, semi-professional, and highly skilled trade areas. It would evoke the most initial interest and have the best chance of success because of years of related curricular developments in technical institutes like Cogswell Polytechnical College.

The Pre-Technology Program which emerged from the Cogswell group was specifically designed for the capable average youngster because he was suffering most from lack of suitable alternatives during his high school education. In general it was felt that he was overchallenged in college preparatory curricula or underchallenged in the terminal tracks. He was the student who would not, in all probability, succeed in a four-year collegiate institution, and who was unaware of his chances for a more rewarding future in a two-year college semi-professional program.

Experience has shown that the vast majority of Pre-Tech students came from those considered marginal, or failing, in the traditional college preparatory sequence. These students were encountering great scholastic difficulty, but were "sticking it out" in spite of the obvious unsuitability of their school work to their needs and abilities.

The Pre-Technology Program, then, is a response to the new educational demands of society. It provides realistic college level goals for the high school student whose academic abilities or interests are less than those required by universities and smaller liberal arts colleges. It provides a socially acceptable escape from the frustrations suffered by a very large group of students whose intellectual abilities are a cut above those required in the typical terminal high school program. It avoids the educational "closed door" inherent in training programs, and encourages latent intellectual abilities. It requires the student raised in a college oriented society to face the skill demands of that same society. Basically, it fills a gap in the intellectual spectrum encompassed by high school curricula so that the student will not have to make an either/or choice. The school becomes better able to accommodate the abilities of its students so that a reasonably good match can exist between the type and level of instruction and the mental and motivational resources of the individual.

The high school has come a long way toward meeting the needs of individual students. It must go even further. In the past, general education for all American youth focused upon common learnings. Now we find general education must keep individual needs well within its sights. As Grant Venn[1] states, "...technology has created a new relationship between man and his work. Although this relationship has traditionally held for some men and some work (on the professional level, for example), modern technology has advanced to the point where the relationship may now be said to exist for all men and for all work."

In spite of the fact that technology today, in effect, dictates the role of the school in preparing man for work, American education has not yet fully recognized this fact of our society. Education's recent affair with the "pursuit of excellence" has left a major portion of our school population behind. Our definition of excellence is still tragically tied to the ten percent who complete four years of traditional college.

While it is true that our schools are not entirely responsible for the present situation, responsive as they are to public attitudes, they have nevertheless offered little challenge to the notion that a four-year college degree is the natural culmination of public schooling. Educators have freely commented on the high number of students placed in inappropriate school programs while not really providing for any other choice.

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[1] Venn, Grant, Man, Education and Work, American Council on Education, Washington D.C., 1964, p.1.

Educators and the lay public must face squarely and honestly the fact that failure to provide these alternatives "pushes out" thirty-five percent of our youth in high school, forty-five percent of those left at high school graduation, and finally forty percent of the remainder during college. Twenty percent receive a two- or four-year college degree in about equal proportions. California, with relatively high holding power in high school, has a sixty percent dropout rate from freshman to sophomore status in its junior college system. They are forced out of a school system oriented toward someone else's college degree rather than their own work needs, and entering a job market demanding more and more cognitive skills; their prospects are indeed bleak.

Excellence in School Programs:

Part of the process of maturation in an individual is making some decision regarding his life's work. This process begins with the adventurous fantasies of childhood. As we become older and more knowledgeable about the specific skill requirements of various jobs, we begin to match our abilities realistically to our ambitions. But this evolution from fantasy to realism is fraught with peril. We become subject to the value judgments of society, and woe to the individual whose acquired interests do not correspond to his inherited and learned abilities!

Some of this development within the individual lies beyond the ability, and even the right, of the school to influence. However, the school does have a responsibility to assist the student in assessing his abilities and interests, and to provide him with knowledge about job requirements. The school should also offer programs to match his occupational interests at various levels of competency with a quality commensurate with the requirements of the new society.

The Pre-Technology Program concerns itself with these five responsibilities:

1) ability assessment;
2) job information;
3) programs of occupational interest;
4) level of instruction; and
5) quality of program.

The first two are initially dealt with by the Pre-Tech counselor and teaching team during the Pre-Tech selection process. Of course, the matter does not end with selection. Even with the tentative commitment made by the Pre-Tech student, teachers and counselors must continually work with him in these areas if the student is to reach his potential.

The American Society for Engineering Education in its report, Characteristics of Excellence in Engineering Technology Education, defines level and quality as follows: "The level of a program is determined by its objectives, and the quality by how well it achieves these objectives." That these two terms, level and quality, are misunderstood is attested to by the fictions still surrounding them. We are still inclined to associate high quality with difficulty and low level with "watering down."[1]

Educational institutions, unfortunately, have contributed to this state of affairs. The above report further states: "Confusion has resulted in many instances, however, because institutions have continued to generalize in their statements of objectives. . . As a consequence differences in level have often been interpreted as differences in quality," and later, "...quality standards can be stated only for a given level of education." Clearly, low level educational programs can be of high quality and high level programs can be of low quality. The measurement of quality depends upon specific statements of program criteria and a method of determining if these criteria are met by the students.

The Pre-Technology Program is a high quality program at a level intermediate between the traditional terminal and college preparatory programs in high school. Quality is not achieved by "watering down", for such simplification does not make the inappropriate appropriate. Quality is achieved by choosing an occupational area of "capable average" intellectual demands (engineering technology, etc.) and rigorously detailing all of the skills, mental and manual, necessary for success in those occupations, followed by objective measures of the attainment of these skills.

Schools need to cast out their "sacred cows" which are holdovers from faulty assumptions of the past. Notions of individual differences must be extended from bare recognition to actual practice in all school programs. A mosaic of intellectual competencies, some high, some low, must be substituted for the concept of the uniformly bright, average, or dull. The school must provide an individually tailored program which corresponds to the student's needs as a working, not a welfare, citizen. In short, a dire need exists to provide quality programs at various levels oriented toward differing interests and abilities.

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[1] Characteristics of Excellence in Engineering Technology Education, The American Society for Engineering Education, University of Illinois, Urbana, Illinois, 1962.

The school has a major responsibility in seeing that the benefits of the technological revolution are realized by all those in its grip. In our rush to pursue excellence we must, in good conscience, consider who is pursuing what. To place an individual in a learning situation beyond his capacity and removed from his interests is like pitting a little league batter against a big league pitcher--the match is ludicrous except for the tragedy that must be suffered. The schools of today and tomorrow must lead the way in bringing about the ideal of "education for all American youth" in a technological society.

The Goal of the Pre-Tech Student is the Technical Team.

Before examining the Pre-Technology Program in greater depth, it is important that we have some understanding of the program goals beyond the generalities dealt with so far.

Historically, man's early technical progress was the result of trial and error experimentation by creative craftsmen. The development of Western science in recent history led to a rapid accumulation of knowledge. Practical applications of this knowledge soon became commonplace as the designers and architects of old adapted the discoveries of science to their work. These early "engineers" spawned the industrial revolution as a result of the motivation of economic necessity, and in a climate of social adaptability. Today, two centuries later, we are in the midst of a new revolution, technological in nature, similarly driven by economic and social forces generated by automation and computerized control. This revolution is being carried out as a boon to mankind, relieving him of the necessity for physical work while exacting a price in increased cognitive work not yet fully appreciated.

The increased sophistication level of all jobs is one aspect of this revolution as it relates to the work-a-day world. Another manifestation has been the very rapid development of occupations whose skills are intermediate between the professional's mind and the craftsman's hands. The middle ground is the province of the technician who must combine mental and manual abilities to match an entire spectrum of new jobs too sophisticated for the manual worker, and too routine for the theorist.

The most effective organization of this skill triumvirate in the new technological society is the technical team. The technical team consists of the professional (such as the engineer), the technician, and the craftsman, each of whom makes his unique contribution to the team effort.

The reader may perceive that the description of the technical team is a simplification of the man levels of competence within each of the categories. Large industrial firms, with their associated laboratories, may divide their professionals into pure scientists, applied scientists, and engineers. Similarly, there exist many levels of technician type jobs.

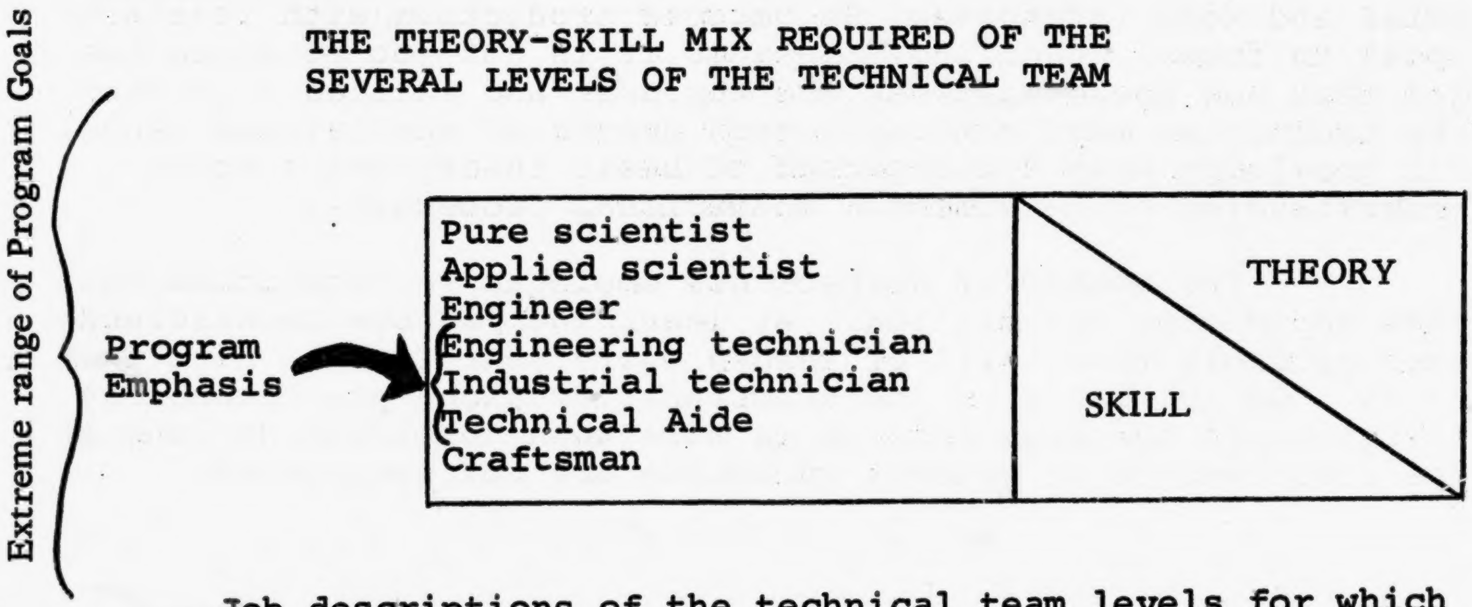
Technician titles are still in a state of flux so that sophistication levels can be surmised only through job descriptions and qualifications. Nor are technicians limited to any particular field. They exist in business, medicine, the graphic arts, engineering, etc.

It is toward this middle level of sophistication that the Pre-Technology Program is oriented. The goal of the program is to prepare the student for post-high school programs which will qualify him to become part of the engineering team at the technician level. The program does not rigidly specify the level of technology in which the student will find success. Our understanding of human drives and abilities is still so imperfect that we would anticipate the initial job entry of Pre-Tech students to range from the craftsman through professional levels. Hopefully, most would find jobs ranging from the industrial technician, closest to the craftsman, to the engineering technician, closest to the engineer.

To better illustrate the personnel divisions within the technical team, it is possible to divide the team into a spectrum of seven levels. Beginning with the scientist and his preoccupation with theory, and ending with the craftsman's attention to precise manual skills, we have the pure scientist, the applied scientist (or scientist engineer), the engineer, the engineering technician, the industrial technician, the technical aide, and the craftsman.

Each of these divisions possesses a theory-skill mixture which is illustrated by the following diagram:

THE THEORY-SKILL MIX REQUIRED OF THE SEVERAL LEVELS OF THE TECHNICAL TEAM


Extreme range of Program Goals
Program Emphasis
Pure scientist
Applied scientist
Engineer
Engineering technician
Industrial technician
Technical Aide
Craftsman
THEORY
SKILL

Job descriptions of the technical team levels for which the Pre-Technology Program was specifically designed are as follows:[1]

Engineer: Usually responsible for planning and supervising the application of scientific knowledge in the development, design, production, construction, sales, operation, and maintenance of engineering products and works.

Engineering Technician: Usually assists a professional engineer by performing specialized tasks under his general supervision. Ideally, two or three engineering technicians assist each professional engineer.

Industrial Technician: Usually assists the engineering technician by performing technical tasks. Ideally, one or two industrial technicians assist each engineering technician.

Technical Aide: Usually performs routine technical tasks under the supervision of an engineering or industrial technician.

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[1] Source: Careers in Engineering, Engineering Technologies, Industrial Technologies; The Junior College District of St. Louis, St. Louis County, Missouri, 1965.

The technician usually specializes in one aspect of engineering. Because of this specialization, his training is brief and more intensive. He becomes productive with less time spent in formal schooling. Because it is his job to close the gap that has opened between the engineer and skilled craftsman, the technician must combine a high degree of specialized technical knowledge with a background of basic theory and a broad understanding of fundamental operational procedures.

The number of workers now employed in technician type jobs approaches one million. At least 100,000 new technicians (and probably more) will be needed every year for the next few years. On the basis of job opportunities alone pre-technology education in our high schools is more than justified as long as the requirements of general education are not overlooked.

The Pre-Tech Concept:

During its initial development the Pre-Technology Program was a direct offshoot of technical institute education, its methods and techniques. The Pre-Tech curriculum was narrowly conceived as having the most applicability in engineering areas.

As the program expanded, and other persons of more general interests became actively engaged, it became apparent that the program was a specific application of an educational concept which might have usefulness far beyond the confines of pre-engineering technology.

Because of the possible broad applicability of the Pre-Tech concept, and because it is convenient and logical to separate the specific subject matter of a school program from its method of presentation, the Pre-Tech concept is here presented without reference to any particular career orientation.

The concept is a process for curriculum development and a method of instruction employing realistic motivation through vocational orientation and learning experiences designed for success. This is done without abandoning the principles of general education which are still fundamental to the purposes of public secondary schooling. The Pre-Tech concept is completed by the 2-2-2 plan, incorporating high school and college as parts of a continuing process of education particularly appropriate to the new technological society.

The concept, per se, does not rely upon any particular vocational orientation or other student qualification. It is adaptable to the needs and interests of any group of students large enough to justify a school program. The concept is also socially timely in its emphasis upon skill formation whether cognitive or motor. All of the techniques used in applying the concept have already been validated by trial, are commonplace in the professional literature, and are widely accepted in practice. The concept offers a unique synthesis, experimental only in its totality.

The Pre-Technology Program hopes to show the compatability of the individual features of the Pre-Tech concept by demonstrating significant improvement in the educational attainments of Pre-Tech students. The program's initial claim to educational soundness is the conservative assumption that the sum of individually sound techniques should produce a significant improvement over that expected from the application of any one technique.

The Pre-Technology Concept Offers a Major Strategy for Educational Success.

The Pre-Tech Program is based upon four fundamental principles:

1. Motivation through vocational orientation and effective teaching.
2. Efficient learning, employing well known learning principles of proven value.
3. The development of a valid, integrated, and correlated curriculum by the teaching team on the school site.
4. The 2-2-2 sequence of high school and college.

The features which uniquely identify the program are classified under the above headings as follows:

1. Motivation through vocational orientation and efficient teaching:

    a) Only students whose interests coincide with the goals of the program are accepted.

    b) Subject matter stresses cognitive and manual skills related to technical occupations, i.e., engineering technology.

    c) Efficient teaching promotes successful learning; past success motivates future success, often at an accelerating pace.

2. A systematic approach to efficient teaching, employing well known learning principles of proven value:

   a) A teaching team is employed, cutting across subject matter areas.

   b) The student is provided with specific behavioral objectives of instruction prior to the teaching of each unit. (Criteria list)

   c) Evaluation is frequent.

   d) The student must demonstrate to himself and his teacher that he has reached the desired objectives with a change in behavior which is measurable. (Criteria test)

   e) Whenever possible, instruction is conducted at the operational level, rather than the theoretical level; e.g., instruction is empirical more often than philosophical.

   f) Application becomes part of the learning process.

   g) Consistent with the emphasis of application and theory is the laboratory technique of measuring empirical relationships. This is the Pre-Tech Program's approach to the discovery method. The discovery of relationships is emphasized over theoretical explanations embodied in a conceptual model.

   h) The student should have some control over the length of time required for subject matter mastery.

   i) The student should have some say with regard to the subject matter taught.

   j) Subject matter should be sequenced in small increments in such a way as to insure correct responses from the student in classroom problem situations.

   k) The student is carefully defined so that the teacher can orient himself with respect to the vocabulary and explanations he can use and the background assumptions he can make.

   l) A list of prerequisites is drawn so that the teachers cannot blame previous schooling for the failure of their students to obtain particular objectives.

m) The teacher must assume some responsibility for using an appropriate instructional technique for the behavior to be learned. Student failure may not be due to poor motivation, but due to an inappropriate teaching technique.

n) As a corollary to (m) above, the student must also be motivated to accept his responsibility for learning.

o) The subject matter in each course is sequenced so as to be useful in the other courses, e.g., vectors are taught in mathematics prior to their use in physics. This process is known as integrating the subject content outlines.

p) The subject matter in each course is integrated and correlated so that the natural relationship of each subject to the others is drawn out and used for constant reinforcement. Wherever possible, subject matter is recycled from one class to another, e.g., vectors may be taught simultaneously in math and science, using two points of view for the common topic.

3. The development of a valid, integrated, and correlated curriculum by the teaching team on the school site.

   a) The Pre-Tech subjects are deliberately taught as "tools" to be used on the job, although general education objectives are never neglected.

   b) Teachers, with the assistance of industrial and college representatives, determine the basic "tool" topics required in engineering technology in each of the subject areas. This forms the base of the Pre-Tech curriculum.

   c) The facts and generalizations which differentiate education from training are stressed, based upon the knowledge that generalizations are transferable and facts are not. Generalizations are abstractions, and abstractions must ultimately be built upon a perceptual foundation. The Pre-Tech curriculum deliberately attempts to do this.

   d) The sophistication level of the program is deliberately controlled by the requirements of engineering technology (rather than requirements of four-year liberal arts college curricula). Pre-Tech students are challenged by teachers who know that a situation can challenge only if the person who perceives the challenge sees a significant possibility of attainment. The resulting Pre-Tech curriculum is not "watered down" in any sense of the word. The program is uniquely designed to meet special requirements.

e) After the topics have been chosen for each subject area, the natural relationships are explored. Subject units are integrated, or sequenced, in such a manner that a topic in math becomes a tool in science, or a topic in science becomes a vehicle for expression in English.

f) After the topics have been chosen for each subject area, and after integration has been accomplished, areas for possible correlation are sought in which topics from one subject area can be reintroduced in another subject area. In other words, there are topics which have in common two or more of the subject areas. Different points of view can be demonstrated for the same principle. In this way a topic can be reinforced by cyclical repetition, and the student can learn how knowledge is transferred from one subject to another.

g) Vocational guidance becomes a part of the curriculum; Pre-Tech teachers and counselor work as a team.

h) Instructional goals are both manual and conceptual. For example, being able to use a centigram balance accurately and consistently is as much an objective as being able to balance a chemical equation on paper.

4. The 2-2-2 sequence, or plan, represents the Pre-Tech conviction that a high school student should complete, in order, the last two years of high school, the first two years of college, and the last two years of college, with the understanding that each two-year period may be considered terminal or continuing, depending upon his achievement.

The Pre-Technology Program is a Specific and Limited Application of the Pre-Technology Concept.

The Pre-Technology Program is a specific application of the Pre-Technology concept. The acceptance of the program by local secondary schools underscores the growing belief that school programs should reflect national needs and student career opportunities.

Admittedly, the program is limited in the number of students it can serve. Attempts to broaden a specific program for the supposed purpose of benefiting more students are often doomed to failure. The very process of broadening has an inverse motivational affect. Depersonalization accompanies wider application until a point is reached where a program is no longer relevant to the student's concept of his interests and ambitions.

Consequently, the Pre-Tech Program does not feel that it could constructively serve more than approximately 30 juniors and 30 seniors in a typical comprehensive high school of 2000 students. This statement should not be construed so as to limit the application of the Pre-Tech concept; rather, each application of the concept is limited as to the number of students it can serve.

Whether because of the good luck often attributed to the foresighted, or to talented planning often claimed in retrospect, the engineering technology emphasis of the program has proven to be an extremely suitable vehicle for the successful demonstration of the concept. In each high school enough interested students were identified to allow some selection. This has enabled each school to make some critical decisions about whom the program could best serve.

The goals of the program were feasible because of an abundance of junior college technology programs for graduating Pre-Tech seniors to enter, and a surfeit of jobs available upon completion of college. Interest has remained high in business and industry, and increases among schools because of the very obvious relationship between engineering technology and the "new" society.

In brief, the program is designed for the "capable average," technically oriented student who has had little success in the traditional college preparatory program. Before placement in the program, some evidence should be available to indicate that some level of engineering technology is a realistic goal for the student. Every effort should be made by counselor and teacher to eliminate from consideration those students whose real needs do not coincide with the expressed goals of the program. Specialized programs such as this are just as sensitive (or more sensitive) to student-class mismatches as the more traditional course sequences.

The "capable average" student is one who has demonstrated in the 9th and 10th grade his ability to perform at or near the "C" level of competence in those college preparatory subjects which are prerequisite to success in engineering technology. Science and mathematics courses are particularly relevant, such as algebra, though not necessarily geometry.

The intelligence quotient as a selective yardstick has been deliberately "played down." The less intellectual can often compensate through hard work and perseverance, commonly succeeding where their less ambitious, but brighter, fellow students fail.

To date, the program has been restricted to boys. It was anticipated that few girls would be interested, and those few would be at a disadvantage in an overwhelmingly male environment.

The program has also been limited to the junior and senior years of high school. Many have argued that this restriction seems unnecessarily rigid in view of the claims by the program for educational soundness at all levels. Quite frankly, the choice of two years was made in order to keep the scope of the demonstration within feasible limits--so as not to "bite off more than one could chew." Other reasons which pointed toward an initial two-year program were:

a) The student should not be required to make even a tentative vocational commitment before age 16, the eleventh grade.

b) The student would be more receptive to the Pre-Tech program after some experience in the traditional college prep program.

c) The student would be easy to identify in the 10th grade (many high schools run 10-12 instead of 9-12).

The Pre-Technology Program is Structured Around the Technician's Job.

In a special issue devoted to "The Swing to Vocational-Technical Education," the Phi Delta Kappan states: "Academic education has never appealed to the majority of American youth nor provided a challenge they could accept. Formerly they dropped out of school, quietly and inconspicuously, at the fourth grade, the sixth grade, the eighth grade, whenever they were fed up or thought they could earn a living. Today the chances of a youngster earning a living have practically disappeared, and we have become so critical that we condemn both the dropping out during high school and the quality of education offered those who remain, while we continue to offer the academic approach that is not appropriate for most potential dropouts."[1]

Grant Venn carries this sweeping observation to a more positive conclusion: "At the tenth grade, twelfth grade and fourteenth grade levels the problem is essentially the same. The educational system strives to give each student every opportunity to develop his talents to the highest possible level. But the highest possible level is always defined as the highest possible level of academic or formal education ... Education pays lip service to the importance of providing an educational response for the wide range of student aptitudes, abilities, and interests, but largely limits that response to general or academic studies of varying degrees of rigor. There are many young people to whom such studies offer little of relevance or challenge, but whose motivations toward educational achievement could be renewed in a more practical program of occupational development suited to their real abilities, aptitudes, and interests ... The value of rigorous liberal studies for the academically talented and of a sound general education for all should not lead to the conclusion that these are the only worthy educational endeavors or that this is where the responsibility of education ends. Occupational education holds the promise of the diversity and practicality that the educational system now lacks in its efforts to educate all our young people to their full potential."[1]

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[1] Phi Delta Kappan, April 1965, "Scraps from a Teacher's Notebook" by Don Robinson.

Although Venn's statement postdates the inception of the Pre-Technology Program, it beautifully delineates what many believe to be the big task facing American secondary education today. For a very large number of students, meaning in education must be found in subjects and curricula related to the world of work.

To organize a school curriculum on an occupational basis could be prohibitively difficult, and might be fundamentally wrong, if the student were required to make specific job choices. The creation of a variety of job curricula would destroy the educational flexibility for which the American comprehensive high school is so well known-- too high a price to pay. This dilemma suggests that schools encourage students to select an occupational class rather than a particular job, so that the school can plan occupationally oriented programs which preserve the fundamental features of general education. This kind of direction for the student is justified by the fact that aptitudes constitute a range rather than a point on a scale. Given scope, men can succeed in a spectrum of occupations commensurate with their abilities.

Consequently, the Pre-Tech Program is organized around the responsibilities of the technician in the technical team. The technician is most concerned with topics which will enable him to produce. Accordingly, each of the Pre-Tech subjects is centered on the job requirements of the technician, which are to bring his knowledge of science, mathematics, English and technical laboratory to bear on practical problems and applications in design, construction and manufacture. The technician's subject needs are the cognitive skills which become his "tools" on the job. Unfortunately, the legitimacy of these needs is still obscured in our schools by misunderstandings regarding subject matter purity, the purposes of education, and of quality at appropriate levels.

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[1] Grant Venn, Man, Education and Work, The American Council on Education, Washington, D.C. p.25

Providing meaningful occupationally oriented education does not mean that the interests and whims of the learner become the controlling factors in his education. The aims of education still must be largely those which are regarded as important to the educating community. However, the teacher must make knowledge available to the pupil in such a way that he can learn. Subject matter becomes sterile to the student unless it has meaning for him. Therefore, school instruction today is a "teaching-learning" process in which the needs of the community must be made to coincide with the needs of the student as he recognizes them. Occupational curriculums give evidence of providing for optimum teaching-learning situations in our schools at all levels, with the understanding that college preparatory programs are just as job centered as technical, service, and craft programs.

The application of this point of view will become quite apparent as the reader studies the sample curricula to follow. It is this occupational orientation which provides the rationale for subject matter integration and correlation which is the essence of the Pre-Technology Program.

The best way to create interest in a subject is to make it worth knowing! The first objective of any act of learning is that it serve us in the future. It is the purpose of the Pre-Technology Program to provide that knowledge which will be useful in the future, and to create in the mind of the student an awareness of its eventual utility.

THE PRE-TECH CURRICULUM DEVELOPMENT PROCESS.

The Pre-Technology Program is characterized by its occupational orientation, its teacher-learner strategy and its process for curriculum development. The curriculum development process is in turn characterized by its relationship to the occupational orientation and teaching strategy of the program.

Starting from the premise that the best way to create a desire to learn is to make the subject matter worth knowing, the Pre-Tech teaching team must determine the manual and cognitive skill and fact requirements of engineering technology related jobs and teach them in such a way that the student is aware of their utility.

This suggests that the teaching team proceed as follows:

1) Determine the cognitive and manual skills needed by the technician on the job.

2) Determine the cognitive and manual skills needed by the Pre-Tech student to succeed in college technology programs.

3) List these skills needed by the Pre-Tech student, preparatory to his entering a technical program in college, by Pre-Tech subject area. The list should be divided into facts and performance abilities.

4) Determine the common teaching units from the skill lists. Units should be self-contained as possible and no longer than two weeks' duration. These units should be sequenced developmentally.

5) Under the common unit heading, list the topics to be covered in each of the Pre-Tech subject areas. These topics should also be sequenced developmentally and integrationally, i.e., the sequencing of topics in one subject should provide for the timely use of these learnings in another subject.

6) Design learning experiences in each of the Pre-Tech subject areas which integrate and/or correlate to the greatest degree possible. The learning experiences should emphasize the "tool" nature of specific subject skills and the multi-subject character of other more general skills which do not fit traditional patterns.

7) For each subject unit, now divided into knowledge and performance skills and learning activities, prepare a criteria list to be handed out to students prior to instruction. The criteria lists should mention, in terms of behavioral changes, everything that the student is to learn.

8) From each subject unit prepared above, make a study guide to assist the student to prepare for day-to-day instruction in each Pre-Tech class.

9) From each subject unit prepared above, make a criteria examination for evaluation purposes. The examination should be designed to evaluate in behavioristic terms, i.e., evaluation is to be made in terms of desired changed behavior.

Determining the Cognitive and Manual Skills Needed by the Pre-Tech High School Graduate.

The Pre-Technology student in high school is preparing himself for two goals: 1) semi-professional programs in junior colleges or technical institutes; and 2) the job of engineering technician at various levels (depending upon the ability of the student).

In order to orient Pre-Tech instruction around engineering technology, the teaching team must investigate the job of technician and college technical programs in order to list the cognitive and manual skills needed by the graduating Pre-Tech student. These skills are not just traditional "bits" of factual knowledge, such as Newton's law of gravity, the quadratic formula, or how to spell "interpolation." They are also performance abilities in which the student uses his factual knowledge to structure a technical report, to employ tabular methods for handling repetitive mathematical calculations, to avoid parallax errors when reading a measuring device, or to create a design based on function and economy rather than upon function alone.

The only way to obtain such a collection of "skills" and facts is by: 1) consulting references on the job responsibilities of technicians; 2) reviewing texts in college technical programs; 3) interviewing persons employing technicians; 4) interviewing technicians, and 5) interviewing college instructors. Of course, some members of the teaching team will also serve as resource people. It is quite likely that the science, math, or tech-lab teacher will have had some technical experiences.

The list of skills and facts should be kept separate in each of the study areas. The team members will probably find less difficulty in listing needed facts than in listing needed skills, but because it is the "skills" list which largely characterizes the Pre-Tech curriculum, it should be most carefully done.

Some confusion may exist regarding "skills" and "knowledge." A skill represents knowledge, of course, but there is a subtle difference. Skills usually involve many "bits" of knowledge, sequenced with judgment, and used to accomplish some purpose. In the past, a skill was knowledge applied through the hands for manufacture. Today, skills are more likely to be cognitive in nature. A typical skill in engineering technology is to apply knowledge in problem situations. A technician may be required to predict the pressure drop along a length of pipe. By measuring the variables involved and applying the appropriate fluid flow formulas, he is able to calculate the pressure drop. He has applied his knowledge of the situation in a useful way.

Briefly, then, a skill is knowledge applied towards a useful end. The key words are "application" and "use."

With help and practice the teacher should be able to couch his teaching objectives in "skill" form, appending to each skill, or list of skills, the necessary "bits" of knowledge required for the skill. Similarly, Pre-Tech subject and/or team units should be expressed in "skill" form. Examples of this are illustrated in the sample curriculum which follows this section.

Integration of the Pre-Tech Curriculum

Integration is the teaching of different skills towards the same end. For example, an engineering technician may be assigned the responsibility of determining the relationship of the muzzle velocity of a "BB", fired from a carbon dioxide cartridge "BB" gun, to the number of "shots" obtained from one carbon dioxide cartridge. The ability to carry out this assignment, with a minimum of supervision, depends upon a basic knowledge of science, math, English, and technical laboratory.

His knowledge of science will enable him to measure the velocity of the "BB" as quickly and economically as possible, say by penetration into a soft substance. His knowledge of mathematics will enable him to derive the velocity from the raw data (depth of penetration) and to make predictions of performance from the limited data thus obtained. His ability to write enables him to make a technical report so that management can utilize his work in deciding upon optimum values for muzzle velocity and "shots." His technical skills, of course, enable him to design and/or set up the apparatus for the experimental tests.

The Pre-Tech student would be capable of carrying out such a project with supervision. His Pre-Tech subject teachers could use the project situation as a practical vehicle for teaching each of their subject skills. Thus, the science teacher would assist the student in finding the natural law relating depth of penetration to muzzle velocity. The math teacher might use the experimental results to teach skills in graphing, interpolating, extrapolating, etc. The English teacher could teach paragraphing, precise writing, or technical reporting, using the "BB" experiment as the subject. The technical laboratory instructor could use the situation as a basis for teaching sketching, drafting, or basic design.

Integration, then, is the establishment of a common unit (purpose) which is used by each team teacher as a vehicle to teach a subject-centered topic. The topics taught in each Pre-Tech class need not be directly related in any way, except that each of the separate skills is necessary to a single job assignment. Each subject contributes as a "tool" towards accomplishing a central purpose.

Sequencing of the Pre-Tech Curriculum

By sequencing, we refer to the listing of subject matter (according to the time of presentation), in such a way that topics in one Pre-Tech subject will be useful in another Pre-Tech subject. For instance, the tech-math teacher may introduce cartesian coordinates and graphing in time for the tech-science teacher to build upon this background by having students present experimental data graphically.

Proper sequencing enables skills in one subject area to serve as necessary tools in another subject area. The utility of knowledge as a tool is emphasized in Pre-Tech philosophy, and proper sequencing is the only way of insuring that the curriculum reflects this "axiom" of the program.

Correlation of the Pre-Tech Curriculum

Correlation refers to all of the Pre-Tech subject areas uniting to teach the same, or differing, aspects of the same skill. These skills must, of course, be broadly defined in order to accommodate each of the Pre-Tech subjects. Such skills are extremely common in technology and many are quite appropriate for Pre-Tech students at introductory levels. At advanced levels many of these skills expand into entire courses, such as quality control, instrumentation, industrial economics, process control, etc. However, the key ideas may be introduced in high school and provide the Pre-Tech team with opportunities to correlate at least some of their subject matter.

To illustrate better what we are trying to describe, let us examine a simple control mechanism employing the principle of feedback. Feedback is an expression which cuts across all subjects. It is not necessarily methematical or physical or communicative. No Pre-Tech subject can lay any particular claim to the principle. Thus, the tech-lab teacher may have the students make a feedback control mechanism, such as a simple water level maintenance device. The science teacher can review the scientific principles upon which the operation of the mechanism is based. The math teacher can have the students graph the results of a trial of the water level device, encouraging the students to discover the fluctuations due to overcorrection inherent in any feedback mechanism. The English teacher may choose to discuss feedback in terms of communication such as post-knowledge influencing future behavior.

In this way each teacher in the team is teaching the same skill. Sometimes a bit of knowledge is reintroduced in each class, and thereby reinforced in the process. Sometimes slightly different aspects of the same skill, or piece of information, are taught in each class, and the student emerges with a knowledge of the whole beyond the capabilities of any one teacher to provide.

By correlation, then, we mean the reinforcement of skill or knowledge from Pre-Tech subject to subject, or the synthesis of a single skill from its "subject" parts.

The Organization of Pre-Tech Units and Topics

Pre-Technology Program curriculum units and topics should have some fairly direct relationship to the needs of the future technician in the college technical program and, later, on the job. As previously mentioned, this implies that the units and topics be organized around the knowledge requirements and duties of the technician, and not around any particular traditional subject.

By unit, we refer to a common body of skills and knowledge towards which all of the Pre-Tech subjects are directed. The unit should be appropriate to the integration or correlation of individual subject matter topics.

The knowledge and skills required of the engineering technician are often subject centered, not lending themselves to correlation. In such instances the unit may apply to a particular subject area, such as science, while each of the other subject areas integrate their topics with this common unit. Examples of such units and topics are listed on the following page:

		Pre-Tech	Subject	Topics
Unit	Science	Math	English	Tech-Lab
Ohm's Law	Ohm's Law	Parametric Equations	Precise Writing	Sketching
Newton's Laws of Motion	Newton's Laws of Motion	Proportionality Constants	Recording Experimental Data	Acceleration Projects
The Technical Report	Calorimetry	Ratio and Proportion	The Technical Report	Heat Treatment of Metals

Likewise, there are skills and knowledge which are not Pre-Tech subject centered, such as product design. These units lend themselves to correlation. In these instances the topics in each

Pre-Tech subject area are obviously related to the central theme, rather than having the unit serve as a vehicle for relatively unrelated subject matter.

The value of both integration and correlation lies in their stressing the artificiality of the compartmentalization of knowledge. Similarly, the correlated and integrated curriculum points up the "tool" nature of each subject, generating considerable student motivation in the process. Correlation has the added advantage of providing for learning reinforcement from subject to subject, and broadening the available subject matter from which the Pre-Tech teachers may select. These "new" topics, or units, may be much more appropriate to the needs of the Pre-Tech student than some traditional topics.

Subject topics thoroughly correlated with the common unit may bear the same, or quite similar, title. The student criteria would, of course, be different from subject to subject. Some examples of units offering an opportunity for good correlation are:

Measurement Errors
Product Design
Quality Control
Design for Optimum Economy
Performance Testing
Process Control
Prototype Manufacture
Maintenance of Equipment

A Pre-Tech curriculum calls for no particular program for integration, correlation or sequencing. Each teaching team will list the needs of its students and set up its own priorities. Knowing and using these curriculum building techniques is good teaching strategy. As long as the process of integration, correlation and sequencing is generally incorporated into a Pre-Tech curriculum, there is no need to worry whether a particular unit, or group of units, is integrated, correlated, or sequenced. It could be all or none depending upon the exigency of the particular curriculur situation. Let us not compound our curriculum problems by replacing old dogma with new, for they may also acquire an aura of artificiality in the absence of good judgment.

Pre-Tech curriculums should not call for an abandonment of all traditional "facts." We simply ask the teacher to generate a "need to know" in his students, to utilize learning techniques conducive to efficient learning, and to direct his teaching toward some useful purpose of which the student is aware or which the student can be made to be aware. Traditional topics which fit the Pre-Tech curriculum design standard should be kept.

The Pre-Tech team should find that they can maintain the basic integrity of their respective subjects within the motivational structure of a Pre-Tech curriculum with little sacrifice. All that is asked is that the teacher present those topics he has always considered fundamental from a new point of view. The Pre-Tech teaching team should think of their subjects as servicing the occupational needs of their students. In view of the desperate need of a very large segment of our high school population for occupational preparation in the new technical society, maintaining subject matter purity at any cost would seem a tragic error.

The Operational Point of View

Engineering (and engineering technology) might be called an operational science. The engineer applies the discoveries of science to practical ends. He is primarily concerned with the fruits of science, and the designing and building of machines and structures for the benefit of man.

The engineer and the engineering technician use many of the techniques of science. However, their purpose is not the discovery of basic causes or explanations, but predicting new uses for known facts. The engineer, then, lives in a world of facts and predictions. His skills lie in the application of those facts.

A fact is defined as "the state of things as they are" or as "a thing that has actually happened." They are based upon observations, and are not inferred. "Steel has more tensile strength than brass" is a fact. "Acids are generally corrosive" is a fact. Newton's Law of gravity is a fact. Electron orbitals are not facts; they have never been seen, but are inferred as explanations for facts.

The engineer is concerned with tensile strength, corrosiveness, and gravity because these are the facts necessary for design and manufacture. The engineer is not particularly concerned with electron orbitals because knowledge of them is not necessary for design and construction. The scientist is interested in electron orbitals because he may use this "explanation" to infer new facts which, when substantiated by experiment, become part of the background of the engineer.

Our initial statement that an engineer is an operational scientist emphasizes his skill in using facts and points up his need for basic explanations as being more cultural than essential. Likewise, the technician is most concerned with, let us say, the tensile of strength of an aluminum alloy rather than a knowledge of metallic bonds, crystalline discontinuities, etc., which "explain" tensile strength. In mathematics, the technician should know that the intersection of two diameters determines the center of the circle. His need to formally prove this geometric statement is questionable.

Using "need to know" as one of the criteria to be used in developing a Pre-Tech curriculum, it would seem that we should take an operational point of view. The Pre-Tech students should learn facts which have a high probability of becoming operational on the job. They should learn operational, rather than theoretical, definitions. They should learn operational skills for the same reason. A good example of an operational definition is hardness. Hardness can be described as the depth of penetration of a steel ball into a given surface, with a standard diameter, applied with a standard force for a standard length of time. There is no theory involved. The definition clearly defines hardness as an act of doing; the definition is concrete rather than abstract. A good example of an operational skill would be the ability of the student to predict the volume of a spherical tank of ten foot radius. He would apply the formula:

$$V = \frac{4}{3}$$

He does not have to understand the derivation of this formula, he merely must be able to use it.

The Pre-Technology Program submits that an operational approach to curriculum is much more valid to the Pre-Tech student than a theoretical approach. It is the nature of engineering technology to be operational. The Pre-Tech student is not, in general, theory oriented (regardless of his academic potentialities) and, consequently, is benefited by a less abstract approach to learning. It is the operational approach which joins the Pre-Tech student so successfully to the Pre-Tech Program.

All of this is not to say that explanations should not be given. Understanding often provides motivation which memorization does not. When filing, pressure should only be applied during the forward stroke. This becomes a nonsensical rule without explanation. Compliance comes, not by penalty, but by being shown that backwards pressure bends down the cutting edges of the file, thus dulling them. Similarly, in English, the teacher must seek understanding by the student for the necessity of conciseness and good grammar. This understanding is best reached by having the students write directions which must be followed by other persons. In this sense, good writing is measured by the success of the person following directions. In both of these examples understanding comes operationally, not theoretically.

The operational approach is closely linked with the necessity of stating Pre-Tech curriculum goals in behavioristic terms. To learn is to be able to do something one could not do before. Learning is best measured as a change in behavior. Pre-Tech subject matter must be operational in order to reach Pre-Tech goals measured in terms of behavior change.

The Teacher-Student Partnership

To define a school situation as essentially a place where teachers teach and students learn is a gross and damaging oversimplification, for it assumes ideals which simply do not exist in actual practice. The more traditional teacher assumes that the student is motivated to learn and has the necessary communicative skills and subject matter prerequisites to profit from the curriculum and its method of presentation. The student is held to blame if these assumptions are not met.

The Pre-Technology Program, in its conservation role, makes no such assumptions. Curriculum and presentation are designed to motivate. Teachers give some thought to what they are going to assume with respect to the prior knowledge and experiences of the student group so that they cannot blame previous schooling for the failure of their students to obtain particular objectives.

This implies that the teacher share with his students the responsibility for learning. Should a teacher or teacher-student designed learning situation fail to bring the student up to minimum criteria standards in the allocated time, then the instructor must assume that the learning experience might be at fault. The student deserves the benefit of doubt and the right to reach the minimum standard of performance for success. Otherwise his time and the instructor's time have been wasted, a "luxury" we can no longer afford. A new approach, a different point of view, an additional small investment in time may be all that is required to generate success from failure. Thus the teacher's responsibility is not to be taken lightly!

To be sure, the learning problems of some students may lie beyond the ability of school, teacher, and the student himself to correct. However, the insurmountable problems of a few students do not relieve the teacher from his responsibility to the majority.

Expressing Pre-Tech Unit Criteria (and its Evaluation) in Terms of Desirable Changes in Behavior Through the Criteria List

To build a curriculum that works, it is necessary to spell in behavioral terms just what the learner will be doing when he is demonstrating that he has achieved the specified objectives. Similarly, before a program can be evaluated, the objectives must be spelled in measurable terms. It is absolutely necessary to specify objectives clearly in order for the teacher to teach and the student to learn.

The importance of preparing a statement of objectives for each educational intent cannot be overemphasized, and the benefits of doing so are many. With objectives (stated in behavioral and measurable terms), it is possible to evaluate the effectiveness of an instructional program. With objectives, there is a sound basis for selecting and sequencing learning experiences. With objectives, it is less likely that the teacher will fall into the trap of equating the difficulty of content with its importance. With objectives, the student is provided a tool which allows him to organize his activities effectively and prevent him from having to develop a bag full of tricks designed to rub the teacher the right way. The teacher will operate in a fog of his own making until he knows what he wants his students to be able to do as a result of his instruction. Every student deserves to know exactly what he is required to learn and why he is learning that particular subject, in terms of what he is going to do in the near future.

Before we begin to discuss what is meant by a meaningfully stated objective, it would be well to make sure we understand what an objective is. There is a great deal of difference between an objective of a course and a description of a course. A course description tells us something about the content and procedures of a course. A course objective describes a desired behavioral outcome. What, then, is a meaningfully stated objective? What we are searching for is a group of words and symbols which will communicate our intent exactly as we understand it. We are heading into trouble if, in writing any of our instructional objectives, we use words such as:

to know
to understand
to really understand
to appreciate
to fully appreciate
to grasp the significance of
to enjoy
to believe

Words open to fewer interpretations and which are less apt to lead us into a trip would be:

to measure
to write
to recite
to solve
to list
to compare
to contrast

The student should never have to second-guess the instructor, his textbook, or the program. He should be told not only what he will be able to do but what he will NOT be able to do. An honest, clear statement of objectives will answer the following three questions:

1) What will the learner be doing when he is demonstrating that he has achieved his objectives? (Since we cannot look into the minds of others, we can only infer the state of their intellect by looking at something they have done or are doing.)

2) What important or special conditions will be imposed on the learner when he is demonstrating his achievement of an objective?

3) What will be considered satisfactory performance--in other words, how will we know that the learner has actually succeeded in achieving the objectives? What will be accepted as evidence of satisfactory performance quality?

We could never, as is commonly done in education today, list a vague and generalized objective for the Pre-Tech student, such as--the learner will develop a certain amount of "confidence" in his handling of some subject matter, or he will develop "critical attitudes." It is necessary to decide for our students just what we will accept as evidence of "confidence" or "critical attitudes," and describe these behaviors as separate objectives.

To state an objective that will successfully communicate educational intent, the teacher will sometimes have to further define terminal behavior by stating the conditions imposed upon the learner. For example:

Without the aid of references
Without the aid of a slide rule
Without the aid of any tool

Instead of simply specifying "to be able to solve problems in algebra," we can improve the ability of the statement to communicate by wording it something like this:

> "Given a linear algebraic equation with one unknown, the learner must be able to solve for the unknown without the aid of references, tables, or calculating devices."

Some questions to ask about objectives, as a guide to the identification of important aspects of the behavior to be developed, might be:

What will the learner be provided?
What will the learner be denied?
What are the conditions under which you will expect the the behavior to occur?
Are there any skills which you are specifically NOT trying to develop?
What do you assume in the way of prerequisite knowledge?

We define a criterion as being a test by which terminal behavior is evaluated. If we can specify at least the minimum acceptable performance for each objective, we will have a performance standard against which to test our instructional programs. We will have a means for determining whether our programs are successful in achieving our instruction intent. Further, the student deserves to have a copy of the desired outcomes prior to studying the unit. This is the criteria list.

For example, it is the responsibility of any good teacher to list expected minimum outcomes at the beginning of any unit of work. He must be specific in stating exactly what it is each student is required to know. The physics teacher, in a unit on machines and mechanics, might list as minimal outcomes:

1) The ability to list and define the six basic machines, orally and in writing.
2) The ability to describe, both verbally and mathematically, the mechanical advantage of each machine.
3) The ability to recognize the factors which will affect the ideal mechanical advantage, particularly the role of friction and its reduction of mechanical advantage.
4) The ability to recognize the basic machines and basic mechanics employed in familiar devices as required by the instructor in the technical laboratory.

Once given this list, the student and the teacher together would meet each of these minimal outcomes throughout the unit.

As part of this same unit on machines and mechanics, The English teacher would list the minimum requirements in a statement such as:

The student will be able to spell and define the following words and phrases:

actual mechanical advantage
efficiency
ideal mechanical advantage
potential energy
power
compound machines
fulcrum

Another way to indicate a criterion of successful performance is to specify the minimum number of correct responses acceptable, or the number of principles which must be applied in a given situation, or the number of principles which must be identified, or the number of words which must be spelled correctly. It is not always possible to specify a criterion with as much detail as we would like. This should not prevent us from trying to communicate as fully as possible with the learner. If we find something we feel sure we cannot measure, the place to put effort is in trying to develop some way to measure it. Further if each student is given a copy of unit objectives - the criterion list - little else may have to be done.

DESIGNING A PRE-TECH CURRICULUM

The Pre-Tech curriculum naturally begins with a description of the engineering technician. The general information bulletin of Cogswell Polytechnical College provides an excellent definition of the engineering technician as follows:

"During the past decade American industry as a whole has made tremendous progress in all technological fields. The success of our industries, and the high level of production which they have attained, have not been so much the results of individual effort as the results of teamwork within the engineering departments of these industries. A constantly increasing amount of attention has been paid by these departments to the organization and functioning of the professional engineer, several engineering technologists, and a group of skilled craftsmen.

"The work of the engineer is largely mental. He has little, if any, of the skilled craftsman's need for the ability to use tools. His job is to study the findings of the research scientists and to visualize projects and ways in which this new information can be put to practical use.

"The engineering technologist finds that his job on the engineering team requires some of the knowledge of the engineer and some of the skill and 'know-how' of the craftsman. His is a job that requires the combination of a high degree of specialized technical knowledge with a background of basic theory and a broad understanding of fundamental operational procedures. In addition to this general requirement, the engineering technologist is usually specialized in one aspect of engineering. Equipped with the proper technical training, he is ready to meet the special responsibilities of his position on the engineering team."

The General Skill Requirements of an Engineering Technician

A job activity analysis of a typical technician's work day would reveal that he works with:

* Instruments
* Equipment
* Tools and machines
* Drawings and reports
* Production
* Materials
* Energy and power

An examination of engineering technician jobs reveals a tremendous variety of responsibilities. Nevertheless, all engineering technicians do have much in common. They work in industry or business. They are commonly involved in manufacturing processes. They are often involved in new product research and design. A general list of engineering technician skills might be:

A. Quality control
    1) Testing and measuring
    2) Instrumentation
    3) Process control systems

B. Product Design
    1) Drafting (formalization of engineer's sketches)
    2) Mock up
    3) Performance testing
    4) Ideas

C. Process Design
    1) Flow charts
    2) Selection of manufacturing techniques and machines
    3) Pilot operations
    4) Assembly line layout

D. Research
    1) Construction of unique test and measurement devices
    2) Construction of prototype models
    3) Conducting experiments

E. Small scale, high precision manufacture

F. Engineering data and reports

G. Maintenance of complex equipment

Lists of More Specific Skills and/or Knowledge Required by Engineering Technicians Arranged according to Pre-Tech Subject Areas

These lists are based upon the teacher's knowledge of the work of a technician gained from publications, interviews with employers, and technicians, plant visits, etc. The topics mentioned are still rather general in nature, and not yet couched in precise behavioral terms. They are incomplete, designed only to illustrate the curriculum development process. They in no way represent a workable curriculum.

These knowledge skills should have a traditional "ring." After all, education in the past has made a sincere effort to teach for utility as well as for culture. The "new departure" offered by the Pre-Tech Program lies more in the integration and correlation of the subject matter, not with a callous disregard of existing educational programs and curricula.

Science:

- Measurement of Physical Properties
- Forces and Vectors in Equilibrium
- Motion:
  - Mathematical Description
- Forces: Newton's Laws
- Work, Energy and Power
- Machines
- Atoms and Molecules
  - The Contemporary Model
  - Inter-Atomic and Molecular Forces Determine Properties
- Pressure:
  - In Fluids
  - In Gases
- Heat
- Wave Motion: Vibration and Waves
  - Sound (in Gases, Liquids, Solids)
  - Light

Mathematics:

- Measurement:
  - Measurement Scales
  - Accuracy
  - Precision
  - Error
- Scientific Notation
- Computation with the Slide Rule:
  - Review of Fundamental Arithematic Processes
  - Estimation
  - Multiplication and Division
- Ratio and Proportion
- Graphing Data:
  - Rectilinear Coordinates
  - Measured Data vs. Functional Data
- The Function:
  - Linear Equations
  - Proportionality Constant, "K"
  - Second Order Equations
  - Functional Descriptions of Relationships
- Making Predictions:
  - Extrapolating
  - Interpolating
- Simple Transformation - a Review of Basic Algebra
- Vectors

- Trigonometry:
  - Definitions
  - Basic Functions
- Geometry:
  - Mensuration of Areas and Volumes
  - Similar Figures

Technical Laboratory:

- Orientation - Safety
- Measuring Devices
- Hand Tools
- Power Tools
- Engineering Materials
- Fabricating Techniques:
  - Machinery
  - Drilling
  - Filing
  - Fastening
  - Shearing
  - Bending
- Applications

English:

- Precise Statements -- the Sentence
- Technical Vocabulary
- Recording Observations
- Directions:
  - Writing
  - Following
- Reading and Study Techniques
- The Paragraph with Technical Applications
- Outlining
- The Brief Technical Report
- Paraphrasing
- Abstracting
- Library Research
- Project Reports
- Oral Reports
- Letters (Brief Reports)
- Literature:
  - Technical
  - Other

Integrated and Correlated Curriculum Outlines, Units and Topics

From this point on, the creativity of the professional teachers in the Pre-Tech teaching team knows no bounds. There is no "best" or "correct" way of sequencing, integrating, correlating--of choosing units, topics and learning experiences.

The cooperating schools in the Pre-Technology Program have been in close agreement regarding the facts and skills required of the pre-technology student. They have drastically differed in their teaching approach. Although the success of the Pre-Tech "method" is closely related to the degree of curriculum integration and correlation, there is no specific formula which this report can provide for accomplishment of this purpose.

Perhaps samples of integrated and correlated units from several of the Pre-Tech schools will help the reader through example. Of necessity, the examples must be sketchy.

Regardless of the differences in approach to the Pre-Tech curriculum by the schools, each individual curriculum is based on a thorough knowledge of facts and skills needed by the students.

In presenting sample curriculum work from several of the Pre-Tech schools, it seems appropriate to begin with an entire year's work perceived as a whole and "zero in" on one particular unit. Therefore, Exhibit 1 is a curriculum outline for one year's work in a Pre-Tech school. Exhibit 2 is a single unit outline as developed by another school. Exhibit 3 consists of the learning activities for a single unit as employed by yet another school. The fact that all three schools included a similar unit, Measurement, in their program is not to be taken as evidence of specific direction from the program office at Cogswell College. Each school independently developed its own curriculum. Measurement was considered of fundamental importance to the technician by all the teaching teams and was emphasized accordingly.

EXHIBIT ONE

Curriculum Outline
for
One Year

EXHIBIT ONE

SCIENCE	MATHEMATICS
UNIT I - THE SCOPE & SEQUENCE OF PHYSICS TOPICS: 1.1 Learning "How and Why" in the laboratory 1.2 Physics and Your Future 1.3 The Engineering Method	UNIT I - THE SLIDE RULE AND MATH REVIEW TOPICS: 1.1 Scientific Notation 1.2 Multiplication Operations 1.3 Division Operations
UNIT 2 - BEGINNING SCIENTIFIC MEASUREMENT TOPICS: 2.1 Technical Data and Reporting 2.2 Measurement and Hooke's Law 2.3 The Measurement of Weight 2.4 The Measurement of Friction 2.5 The Measurement of Pressure 2.6 The Measurement of Time 2.7 The Measurement of Heat 2.8 The Measurement of Work	1.4 Squares and Roots 1.5 Combined Operations 1.6 Cubes and Cube Roots 1.7 Ratio and Proportion UNIT 2 - ALGEBRA REVIEW TOPICS: 2.1 Signed Numbers and Operators 2.2 Grouping 2.3 Laws of Exponents 2.4 Algebraic Products

ENGLISH	TECH LAB
UNIT I - HOW TO STUDY FOR TECHNICAL COMPETENCE TOPICS: 1.1 Appearance and Format of work 1.2 Study Skills and Habits 1.3 How to Do Engineering Experiments and Reporting	**UNIT I- THE SCOPE & SEQUENCE OF TECH LAB** TOPICS: 1.1 The Technician Looks at Safety 1.2 The Job Ahead of You 1.3 Applying the Engineering Method - How and Why Together
UNIT 2 - GRAMMAR & USAGE FOR TECHNICAL WRITING TOPICS: 2.1 The Simple Sentence 2.2 The Work of Modifiers 2.3 Building Better Sentences 2.4 Understanding the Sentence Unit 2.5 Using Verbs Correctly 2.6 Agreement of Subject and Verb 2.7 Choosing the Right Modifier 2.8 Using Pronouns Correctly	**UNIT 2 - SCIENTIFIC & TECHNICAL MEASUREMENT TECHNIQUES** TOPICS: 2.1 Linear Measurement and Degree of Accuracy 2.2 Shop Techniques - Linear Measurement 2.3 Scalar and Vector Quantities 2.4 Handbook Data and Equations

SCIENCE	MATHEMATICS
UNIT 3 - BEGINNING THERMODYNAMICS & TECHNICAL APPLICATIONS TOPICS: 3.1 Laws Theories and Effects of Heat 3.2 Heat Properties and Measurement 3.3 The Principles of Heat Transfer 3.4 The Thermodynamic Character of Common Materials	UNIT 2 - ALGEBRA REVIEW (Cont'd.) TOPICS: 2.5 Division 2.6 Factoring 2.7 Addition and Substraction 2.8 Complex Fractions
3.5 The Mechanical Equivalent of Heat 3.6 The Elements of Heat Engines	UNIT 3 - LINEAR EQUATIONS TOPICS: 3.1 The Cartesian Plane
3.7 Distillation Processes and Salt Water Conversion	3.2 The Formula for the Distance Between Two Points 3.3 The Formula for the Mid-Point 3.4 The Slope Intercept

ENGLISH	TECH LAB
UNIT 2 - GRAMMAR & USAGE FOR TECHNICAL WRITING (Cont'd) TOPICS: 2.9 How to Use Capitals 2.10 Learning to Use Commas 2.11 Apostrophes and Quotes	UNIT 3 - APPLIED THERMODYNAMICS TOPICS 3.1 Safety Practices With Heat 3.2 Heat Equipment and Operation 3.3 Gas Welding Theory and Practice 3.4 Arc Welding Theory and Practice
UNIT 3 - WORD STUDY TOPICS: 3.1 The Greek Alphabet	3.5 Foundry & Forge Technology 3.6 Linear Expansion Problems in Welding and Machining
3.2 Supportive Technical Vocabulary 3.3 Non-Technical Vocabulary 3.4 Dictionary Use	3.7 The Effects of Heat on Common Materials and Preventive Maintenance

SCIENCE	MATHEMATICS
UNIT 4 - BEGINNING ENGINEERING MECHANICS & TECHNICAL APPLICATIONS TOPICS: 4.1 Principles and Mathematics of Mechanics 4.2 Force Systems and Their Description 4.3 Moments and Torques	UNIT 3 - LINEAR EQUATIONS (Cont'd) 3.5 Graphing 3.6 Simultaneous Equations 3.7 Determinants
4.4 The Equilibrium Equations 4.5 The Statics of Rigid Structures 4.6 Machines, Energy, and Work	UNIT 4 - VERBAL PROBLEMS TOPICS: 4.1 Number Type Problems 4.2 Geometric Type Problems 4.3 Leverages
4.7 The Kinetic Theory of Energy 4.8 The Principles of Fluid Mech. 4.9 The Mechanics of Gases	4.4 Motion Type Problems 4.5 Combination Type Problems

ENGLISH	TECH LAB
UNIT 3 - WORD STUDY (Cont'd) 3.5 Spelling UNIT 4 - TECHNIQUES AND APPLICATION FOR TECHNICAL WRITERS TOPICS: 4.1 Paraphrasing 4.2 Describing Apparatus and Systems 4.3 Data Form Development	UNIT 4 - MECHANICS AND MATERIALS TOPICS: 4.1 Soldering for Joint Strength 4.2 Welding for Joint Strength 4.3 Testing Joints for Strength 4.31 Testing welder joints 4.32 Testing fastened joints 4.33 Testing nailed joints
4.4 Writing Up Experiments 4.5 Reporting Progress 4.6 Writing Memoranda	4.4 Belt Tension and Bearing Life 4.5 Force Systems in Machines 4.51 Linkages 4.52 Leverages 4.53 Gears & Cams 4.54 Balanced Forces 4.55 Unbalanced Forces
4.7 Letter Writing 4.8 News Reporting 4.9 Critique Writing	4.6 Measuring Torque for Machining Formulas

SCIENCE	MATHEMATICS
UNIT 5 - THE MECHANICS OF SOUND WAVES & TECHNICAL APPLICATIONS TOPICS: 5.1 The Nature of Vibrations 5.2 The Periodic Function and The Sine Curve 5.3 Simple Harmonic Sound and its Mathematical Description	UNIT 5 - ELEMENTARY TRIGONOMETRY TOPICS: 5.1 Cartesian Vectors 5.2 Sine-Cosine-Tangent Laws 5.3 Angles by Degrees and Radians 5.4 Trig Tables 5.5 Right Triangle Computations with Tables
5.4 Damped Vibrations and Noise Control	5.6 Right Triangle Computations with the Slide Rule 5.7 Right Angle Vector Computation
EVALUATION	EVALUATION

ENGLISH	TECH LAB
UNIT 5 - SPEECH FOR TECHNICAL COMMUNICATORS	UNIT 5 - PROBLEMS OF SOUND & NOISE CONTROL
TOPICS:	TOPICS:
5.1 The Importance of Speech	5.1 Diagnosing Machinery Mal-function by Sound
5.2 Types of Speeches	5.2 How Sound is Produced Mechanically
5.3 Speech Preparation	5.3 Isolating Engine Noises and Vibrations
5.4 Speech Delivery	
5.5 Pronunciation	
5.6 Parliamentary Procedure	
5.7 Social Graces	
EVALUATION	

EXHIBIT TWO

INTEGRATION CHART
MEASUREMENT OF RELATIONSHIPS

SCIENCE

UNIT: - THE MEASUREMENT OF RELATIONSHIPS

A. OBJECTIVES:

1. To understand and be able to define the concept of viscosity.
2. To understand the concept of a scientific relationship.
3. To be able to measure experimentally the viscosity of several liquids.
4. To know the simple technique of making precise and reliable temperature measurements with a mercury thermometer.
5. To be able to draw a graph of a scientific relationship.
6. To be able to apply mathematical descriptions to simple curves on a Cartesian graph.

B. LEARNING ACTIVITIES:

1. Study Chapter 4 of text: "The Role of Mathematics in Science."
2. Problems 1-5, pages 28-29 of text.
3. Experiment: To measure the viscosity of a liquid and its relationship to temperature.
4. Experiment: The relationship between viscosity and density.

TECH LAB

UNIT: - MEASUREMENT OF RELATIONSHIPS

A. OBJECTIVES:

Students will

1. Continue, through this and each succeeding unit, to develop the habit of using tools and equipment correctly and safely.
2. Develop the knowledge and skills required to construct the projects and equipment needed in the math and science classes.
3. Become familiar with drills, drill presses, and all Tech Lab hand tools.

B. LEARNING ACTIVITIES:

Students will demonstrate the above objectives by

1. Passing appropriate tests, both written and practical.
2. Constructing the required science and math equipment, i.e., a viscosimeter.

MATHEMATICS

UNIT: APPROXIMATE CALCULATION

A. OBJECTIVES

1. Students will sharpen and extend their arithmetic skills working for speed and accuracy.
2. Use of the slide rule for basic operations and for solving proportions is to be initiated and some degree of skill attained.
3. They will learn shortcuts and checking procedures.

B. LEARNING ACTIVITIES:

The students will do these things:

1. Apply arithmetic operations to physical situations.
2. Improve speed and accuracy by practice and shortcuts in longhand arithmetic and by use of the slide rule.
3. Relate ratio and proportion to fractional divisions of a linear scale.
4. Perform experiments with numbers which illustrate their basic properties under common operations.
5. Interpret meaning of literal notation as found in formulas. Understand use of parentheses and exponents.
6. Understand and recognize the variable parts of a formula.

ENGLISH

UNIT: HOW TO BE PRECISE IN WORDS

A. OBJECTIVES

1. To develop awareness of and a technique for exact, lucid, colorful language through appreciation of the function of adjectives and adverbs.
2. To understand the function of prepositional phrases as a means of contrasting ideas and "bridging" one's thoughts from one paragraph to another.
3. To develop skill in using such modifiers as adjectives, adverbs, and prepositions.
4. To master assigned vocabulary from all Pre-Tech subjects.

B. LEARNING ACTIVITIES:

1. Identify in sentences adjectives, adverbs, and prepositions.
2. Transform sentences containing sparse, bare statements into vivid language via the use of such modifiers.
3. Compose original sentences using facts from other Pre-Tech subjects, expressed in precise, exact words.

MATHEMATICS

UNIT: APPROXIMATE CALCULATION (Cont'd)

7. Understand and use the concept of parameter in a formula.

8. Evaluate a given formula by substitution of a given number.

9. Make a table of data for a given formula and several given numbers.

EXHIBIT THREE

A Sample Unit on Measurement of Relationships

SCIENCE

UNIT: The Measurement of Relationships

UNIT DISCUSSION

The word science wears many hats. What is a fireman without his hat? In a similar vein, what is a scientist when he is not wearing the fanciful hat which proclaims to all that he is a master in the art of measuring and discovering relationships?

Any technically oriented person is also a scientist in that he must master composition of iron to its physical properties, such as tensile strength and toughness. It has been found that the per cent carbon dissolved in iron determines the strength of steel. It is very important for the steel manufacturer to be able to predict the strength of the steel he is selling by its carbon content. If this were not true, how could a designer of a steel structure be reasonably certain that his creation will not collapse?

You will learn some of the techniques used in discovering relationships in this unit. Your science teacher has many experiments which can help you learn these techniques. He is choosing an experiment on viscosity vs. temperature because it is an important physical relationship used in the design of machines. It is also an experiment which involves the manufacture of a very simple piece of apparatus in Tech lab.

Lastly, you will also learn that it is important to recognize when a relationship does not exist. Using your "viscosimeter" you will determine viscosity of liquids whose densities you have measured in a previous experiment. A graph of viscosity vs. density should "tell the tale."

Criteria: You must know or be able to do each of the following:

1. Make a viscosimeter.
2. Know the definition of:
   viscosity
   ordered pair
   "Scientific" relationship
3. Understand the principle of operation of the viscosimeter you have made.
4. Be able to use a viscosimeter in reliably measuring viscosity.
5. Be able to make reliable centigrade temperature measurements with a mercury thermometer.
   a) This involves knowing where to hold the bulb of the ther-

mometer when measuring the temperature of a body of liquid.

b) This also involves the understanding of the necessity of constant agitation for reliable temperature measures of a liquid.

6. Be able to draw a proper graph showing a relationship or lack of relationship between two properties.
   - a) This includes an appreciation of the necessity for neat, logical and thorough labeling.
   - b) You must draw a graph as you would a project in mechanical drawing, i.e. using a straight edge, using different pencil weights, correctly centering the graph, etc.
   - c) You must learn to circle all measured points on a graph.
   - d) You must be able to draw a smooth curve through a set of measured points on a graph, the curve averaging the points rather than passing through each one. This is in recognition that a measured point may be in error and consequently, half the points not on a curve should be above and half below.
   - e) You must understand the terms:

versus	function
vertical axis	Linear scale
horizontal axis	

   - f) You must learn which quantities are placed on which axis.

Vocabulary List:

viscosity: (fill in definition)
viscosimeter:
"scientific" relationship:
ordered pair:
function:
versus:
vertical axis:
horizontal axis:
scale:
curve:
calibration: (verb:-to calibrate)

Study Guide:

Text: Physics by Elliot & Wilcox
Read and study Chapter 4: The Role of Mathematics in Science

Written Assignments:

1) Problems 1-5, pages 28-29 of text.
2) ....

Experiment 1:

To measure the viscosity of a liquid (cottonseed or mineral oil) and its relationship to temperature.

Discussion:

In this experiment you will construct a viscosimeter (described below) and measure the viscosity of oil at different temperatures. With this experiment you will learn the exact meaning of viscosity. As a technically oriented person it is important that you use words correctly, for only through correct word usage can you say exactly what you want to say in concise and logical fashion, easily understood by others. Don't be like the layman who says that syrup is heavy when he really means it is viscous. How confusing our language must be to a foreigner. We like "thick" syrup on our pancakes, a new car takes "light" oil; an older car might take 30 "weight" oil. What a "viscous" muddle of terms we have when we are not scientific!

Many of these expressions came into vogue because people thought that there were relationships, when none really existed. For example, most people believe that a viscous substance is denser than a less viscous substance. They say that the "heavier" a liquid is the more "viscous" it is. Is this really true? In this experiment you will use the technique of graphing to prove a relationship between viscosity and temperature. In the next experiment you will use the same graphing technique to show whether a relationship exists between viscosity and density (or "heaviness").

Method

1. Your apparatus is a small frozen juice can, open at one end and with a uniform hole (1/16 to 1/8 inch) drilled in the center of the other end. The hole is stoppered with a wooden dowell which is fastened so that it cannot be jarred loose.

2. With a graduate cylinder measure 50.0 cc. of cottonseed (or mineral) oil into the stoppered juice can.

3. With a thermometer, measure in ^{o}C, the temperature of the oil. Take care not to lose any oil as you withdraw the thermometer. (Dip the thermometer up to its immersion level in oil before you place it in your can of oil.) Your teacher will help you develop this technique.

4. Hold the juice can over a 250 cc. beaker. Using a watch with a second hand (be sure to bring one from home if possible), pull the stopper at "O" sec. and measure the time it takes all the oil to drain from the can. It is assumed the oil flow stops when the stream ceases (in other words, do not time drops). Record this data on a properly prepared data sheet. (Your instructor will help you prepare the data sheet in advance of the experiment. A carbon copy of your data sheet will be required at all times.)

5. Repeat the experiment, heating the oil in the juice can to approximately 40.0°C. The temperature does not have to be exactly 40.0°C, but you must measure the temperature of the oil as precisely as possible just before measuring its viscosity. You can heat the oil in a water bath, using a large beaker, stand, and bunsen burner. While heating the oil, be sure the stopper does not come loose. Record data.

6. Repeat again at approximately 60.0°C, and 80.0°C. Record data.

7. By definition, the viscosity of a liquid is the time it takes a unit quantity to flow out of a uniform hole in the bottom of a container. The time in seconds, then, will be your measure of viscosity. Plot this data on a graph: viscosity (time of flow) versus temperature.

8. Clean your apparatus with a suitable solvent, wash with soap and dry.

Questions:

1. Can you describe in words the relationship between viscosity and temperature?

2. Does the viscosity of all liquids change with temperature in this way? Hypothesize!

3. Suggest an experiment or experiments which will tend to prove or disprove your above hypothesis.

NOTE: Copy question or include with your answer.

Report:

1) Data sheet
2) Graph: Viscosity vs. Temperature
3) Questions

Experiment 2:
The relationship between Viscosity and Density

Discussion:

By use of the same techniques you used in the last experiment you should be able to tell whether viscosity is or is not a function of density.

Method:

1. Measure the viscosity (with your viscosimeter) of the following liquids at room temperature:

   alcohol (ethyl)
   water
   carbon tetrachloride
   carbon disulfide
   oil (from last experiment)

2. Find the densities of these liquids from the record on your data sheet for Experiment 3, Unit I. Record same on your data sheet. (Use a general reference for the oil such as the Handbook for Chemistry and Physics).

   (output) (input)

3. Plot the order pairs of data, viscosity vs. density, for each liquid on a graph.

Questions:

1. If the plotted points form an irregular pattern, how will the smooth curve be drawn? Can you draw a smooth, regular(??) curve through the points?

2. Does your experimental data suggest a relationship between viscosity and density. If your answer is "yes", explain your reasoning. If your answer is "no", state your reasons for the answer.

Pre-Tech Mathematics -- UNIT: The Measurement of Relationships

Discussion:

During this unit you will learn to improve your mastery of arithmetic skills, but new skills will also be learned which will allow you to estimate the answer to math problems with great speed and only a small loss in accuracy. You will learn basic calculation with the slide rule, a tool of lifelong use to you.

Criteria:

1. Apply principles of graphing to actual experiments in science.
2. Understand the concept of FUNCTION as an input-output relationship and tell how the relation is described in reports.
3. Apply properties of basic operations to simplify numerical problems, especially commutative, associative, and distributive properties of addition and multiplication. Use the properties of inverse operations to simplify calculations.
4. Use rules of approximate calculation to obtain sufficient but not unjustified accuracy. Know how to round off numbers.
5. Calculate reliably with slide rule. Be able to multiply, divide, take square root or square numbers, and do proportions on the slide rule.
6. Be familiar with the nature and use of proportions.

Vocabulary:

1. difference (in a subtraction problem)
2. divisor
3. expand
4. expression (as opposed to "term")
5. factor (both noun and verb are needed)
6. function (precise scientific meaning of the noun)
7. locus of points
8. multiple (noun)
9. product (in a multiplication problem)
10. proportion, proportional
11. quotient (in a division problem)
12. ratio (as opposed to a proportion)

13. set (what makes a set a set?)
14. sum (of an addition problem)
15. term, lowest terms, higher terms
16. variable quantities (input or output variables)

Experiments:

See Tech science

Textbook work:

Work in depth on properties of numbers and operations (pg.9-17)
Careful study of approximate calculation rules (pg. 27-30)
Study and practice with slide rule operations (pg. 35-43)

Supplementary Information Sheets:

1. Operational Approach to Science and Math
2. Understanding and using Proportions

Pre-Tech Mathematics--UNIT: The Measurement of Relationships

Information sheet 1 -- The Operational Approach to Science and Math

Use the operational approach to science and math in planning and doing your Pre-Tech work. In this approach we try to give a working description of what we do and what we observe, rather than give a deeper philosophical explanation of why something happens in science.

1) Operational description of objects (things):

A working description of physical quantities (or variables) measured in your experiments would consist of a list of the most important properties together with the units used in their measurement.

2) Operational description of relationships:

A working description of scientific laws or relationships between physical quantities would be one of the following:

a) Word statement telling how one of the quantities or variables changes as the other variable changes. You would have observed these changes in your experiments, and recorded the results neatly in tables.

b) Graph or locus of points showing at a glance how one variable changes as the other variable increases. If we think in terms of cause and effect, the input variable would be the cause, and the measured or observed result would be the effect. It is customary for the input variable to be plotted horizontally on the graph. Then the effect, or output variable, would be plotted vertically. The number pair, representing cause and effect, would be located on the graph as a point and would be circled. The set of all these observed causes and effects would form a set of points or "locus of points." The locus of points shows the relationship of input to output at a glance.

c) Formula. A concise mathematical description of the value of the output obtained by performing certain indicated mathematical operations on the input. By listing a number of inputs and performing the operations on each as indicated in the formula, we would have a good idea of the entire input-output relationship.

d) Data table--a table listing all necessary inputs and the corresponding output for each input. List input first, then output. The data may be derived either from experimental observation or it may be calculated by formula.

From the number of ways of listing or describing relationships, you may have concluded that the scientist and technician are more concerned with relationships than with describing things. You are right! In fact, the relationship between input and output has become so important an idea in both math and science that it has been given a special name. It is called A FUNCTION.

Think and work operationally! It will certainly add to your success in the Pre-Tech program and develop excellent habits for your future career. Budget your study time wisely; learn to study efficiently; in problem solving, always make sure you understand the problem and what outcome is being sought before attempting a solution; in English, learn to express your ideas as precisely and briefly as possible; describe objects operationally in terms of qualities and definite properties that can be measured; describe relationships only in terms of calculations or observations. The technician works only with the tangible and measurable.

Pre-Tech Mathematics -- UNIT: The Measurement of Relationships

Information sheet 2 -- Understanding and Using Proportions

Why is the PROPORTION the most useful mathematical tool that the technician has at his disposal? Not only is it very simple to set up and use, but also it is made to order for mathematically describing most relationships of science.

A sampling of uses:

1. Converting from one unit system to another.
2. Distance-rate-time problems.
3. All linear relationships.
4. Molecular distribution and % composition chemistry problems.
5. Changing % to decimals and fractions.
6. Condenser discharge and Ohm's law problems.
7. Thermodynamics problems.
8. Strength of materials problems.
9. Work, power, and energy calculations.
10. Interpolation in trig and log tables.
11. Finding sides of right triangles in trigonometry.
12. Finding slope of a line.
13. Boyle's law and Charles' law problems on gases.
14. Relationship between Centigrade and Fahrenheit temperatures.
15. Any inverse relationships.

If this list is not impressive enough, consider that the engineer also finds proportions of great use in problems involving complex non-linear relationships. He simply lets a proportion approximate the true formula and inserts a sufficiently large safety factor to take care of errors caused by the simplified mathematics. Thus, almost any problem will either be solved or approximately solved by using proportions.

What are the parts of a proportion? Two equal ratios $\frac{a}{b}$ and $\frac{c}{d}$.

But what are these two equal ratios equal to? A constant number K, sometimes called the constant of proportionality.

You can use your knowledge of algebra and longhand arithmetic to solve any proportion with 3 terms known for the fourth term. If not, now is the time to get your math teacher to show you.

The easy way to solve for the fourth term of a proportion, although not the most accurate way, is by use of the slide rule. Since only multiplication and division are involved, the C scale and D scale are used. Locate the numerators of the proportion over the corresponding denominators. FIND THE DENOMINATORS FIRST ON THE D SCALE, THEN LOCATE THE NUMERATORS ON THE C SCALE JUST ABOVE THEIR CORRESPONDING DENOMINATORS.

Example: Find X in the proportion $\frac{5.2}{13} = \frac{X}{20}$. Find 13 on D scale. Place 5.2 over it on C scale.
Now move hair line to position over 20 on D scale. On C scale you should read: 8
You see, once any numerator of a proportion is located over the corresponding denominator, the relationship is set for any numerator and denominator proportional to the first two. Practice using the slide rule to solve proportions and check your work by longhand.

TECH LAB

UNIT: Measurement of relationships

Discussion:

The first item of business for this unit will be the construction of a viscosimeter (see experiment Number 1, Tech Science Unit 2). In conjunction with this project you will learn to use some of the measuring devices available in Tech Lab. You will also become familiar with the use, care, and operation of the other tools necessary for the construction of the viscosimeter.

Criteria:

You must know and/or be able to do each of the following:

1. You should be able to locate the center of round stock using the center square.
2. You should be familiar with the hand drill and its proper use.
3. The twist drill is the drill most used in metal work.
4. Twist drills are made of two kinds of steel. You should be able to name them and give the advantages of each.
5. You must be familiar with both straight and tapered shank drills.
6. The taper used on twist drills in the Morse taper - about 5/8" per foot.
7. A. Number size drills
   Number 80, smallest to number 1, largest
   B. Letter size drills - A to Z, A the smallest to Z, the largest. Letter drills start where number drills leave off.
   C. Fraction size drills - 1/64" to 4" or larger.
8. When requesting drills the following information is given:
   A. Diameter of the drill
   B. Shape of the shank
   C. Kind of steel
9. You should be able to make a setup on the drill press. This includes the following:
   A. Material held in place
   B. Correct drill
   C. Correct drill speed
   D. Correct feeding procedure
10. Rule for cutting: The cutting tool must be harder than the material to be cut.

11. You should know the factors which determine correct drill speed.
    A. Drill diameter--the smaller the drill, the faster the speed.
    B. Kind of steel in the drill--high speed steel drills can be used at twice the speed of carbon drills.
    C. The hardness of the metal being drilled--the softer the metal, the greater the speed.
12. Feed the drill as fast as it will cut until it starts to break through; then, let up on the feed pressure and let it cut through slowly.
13. Understand the use of a pilot hole.
14. You should know the procedure for grinding twist drills by hand.
15. You should be able to identify and explain the following terms:
    A. Lip clearance
    B. Angle of lip clearance - 12°to 15°
    C. Length of lips
    D. Angle of lips - 59°
    E. Rake angle - manufactured into the drill
16. You should know the proper procedures for using and caring for micrometers.
17. You should be able to read a micrometer accurately.
18. You must be able to identify the following tools and pieces of equipment:

    1. Machinist's hammer
    2. Scriber
    3. Prick punch
    4. Center punch
    5. Dividers
    6. Outside caliper
    7. Inside caliper
    8. Hermaphrodite caliper
    9. Steel tape
    10. Steel rule
    11. Combination square
    12. Center head square
    13. Solid steel square
    14. Surface plate
    15. Inside micrometer
    16. Micrometer
    17. Vernier micrometer
    18. Hack saw
    19. Jeweler's saw
    20. Flat cold chisel
    21. Cape cold chisel
    22. Single cut file
    23. Double cut file
    24. Twist drill
    25. C Clamps
    26. Drill vise
    27. V - Block
    28. Countersink
    29. Combination drill and countersink
    30. Machinist's vise
    31. Combination plier
    32. Side cutting plier
    33. Screw driver
    34. Offset screw driver
    35. Phillips' Head screw driver
    36. Adjustable end wrench
    37. Vice-grip wrench
    38. Open end wrench
    39. Box end wrench

40. Monkey wrench
41. Rivet set
42. Scratch awl
43. Setting hammer
44. Tin snips
45. Aviation snips
46. Wheel dresser
47. Hand groover
48. Chipping hammer
49. Mallet
50. Wire brush

Vocabulary list:

1. clearance
2. diameter
3. feed
4. measure
5. tapered
6. tolerance
7. standard
8. procedure
9. accuracy
10. flutes

Study Guide:

Text: Metalwork by Ludwig
Read: Unit 25 - Drills, Sleeves, Sockets, and Chucks
Unit 26 - Drill Sharpening
Unit 10 - Micrometers
Reference: Experimentation and Measurement by Youden
Read: Pages 80 - 83

Written Assignments:

1. Question Set No. 1
2. Question Set No. 2

Projects for Science

1. Viscosimeter

TECH LAB

Question Set No. 1

1. How do you decide whether to use a two-lip twist drill or a four-lip twist drill?

2. What does "H.S." stamped into a drill shank mean?

3. Name two kinds of drill shanks used most commonly with metal.
   A.
   B.
4. What are the four uses of drill flutes?

   A.

   B.

   C.

   D.
5. Which drills are larger: drills designated by gauge numbers or drills designated by fractions?

6. What three things must you know to order a specific drill?

   A.

   B.

   C.

7. Which drill is larger, No. 60 or No. 40?

8. Give three ways you could find the size of a drill.

   A.

   B.

   C.

9. What is the rake angle?

10. What is lip clearance?

TECH LAB

Question Set No. 2

1. What is a micrometer?

2. What are the four steps to mastering the micrometer?

   A.

   B.

   C.

   D.

3. Name the six parts to the micrometer.

   A.

   B.

   C.

   D.

   E.

   F.

4. Name three kinds of micrometers.

   A.

   B.

   C.

5. What is the purpose of a ratchet stop on a micrometer?

6. What is the difference between a regular micrometer and a Vernier micrometer?

7. Can you measure 1/4" stock with a 2" micrometer? Why?

   A.

   B.

8. What is the smallest size that you can measure with a 4" micrometer?

9. How many threads per inch are there on a micrometer screw?

10. What is the decimal equivalent of 1/16"?

TECH LAB

Criterion Test Part I

Place the appropriate response in the space provided at the right.

1. There are three different sets of drill sizes. Name them and give the smallest drill size in each set.

A.____ a.____

B.____ b.____

C.____ c.____

2. What three items of information are needed when ordering a specific drill?

A.____________

B.____________

C.____________

3. What are the three factors which determine drill speed?

A.____________

B.____________

C.____________

4. What kind of taper is used on twist drills? 4.____________

5. Explain the purpose of the pilot hole. 5.____________

____

____

6. What is the rule for cutting which applies to all cutting tools? 6.____________

____

____

7. Which of the following is manufactured into the twist drill and is not changed by sharpening? 7.____________

A. Lip clearance
B. Angle of lips
C. Length of lips
D. Rake angle
E. Angle of lip clearance

8. Twist drills are made of two kinds of steel. Name them and give the main advantage of each. 8. ____________

____

____

____

9. What is the main difference between the two drills being shown other than size? 9. ____________

____

10. What is the purpose of the lip clearance on a twist drill? 10. ____________

11. Name the three different ways that drill size is indicated. 11. ____________

____

____

12. Which of the above drills are the smallest? 12. ____________

Write true or false, on the lines provided at the right, to indicate your response to the following statements:

1. When drilling, let up on the feed pressure as the drill starts to break through the material 1. ____________

2. When drilling, the softer the metal to be drilled, the slower the drill speed to be used. 2. ____________

3. When drilling, the smaller the drill to be used, the faster the drill speed to be used. 3. ____________

4. The twist drill is the drill most often used in metal work. 4. ____________

ENGLISH

UNIT: Measurement of Relationships (How to be Precise in Words)

Discussion:

In your other Pre Tech subjects you are continuing to learn about measurements--precise, specific measurements. Also, you are learning techniques for recording these measurements so they can be duplicated by others as a test of reliability.

In English, too, we shall study techniques by which we make our ideas more clear and precise, or expand and develop our thoughts. For example, ever since you have attended school you have heard that "Good work is one of our major satisfactions in school." What is good work? Work that is morally valuable or socially useful? Or do we mean work performed in a careful, intelligent manner--work that reflects clear thought and precise expression of that thought? You can see at once that the word good in the sentence above is poorly chosen, since we have no sure understanding of its meaning. Such use of words reflects what we call "fuzzy" thinking; it is a sign of mental laziness.

Fortunately, however, the English language offers complete excape from this kind of mental spiderweb. Consider how much more understandable that sentence is this way: "Clear, thorough, well executed academic work is one of our major satisfactions in school." The words clear, thorough, well executed and academic all have the function of explaining, clarifying, and limiting the ideas we are discussing on the subject of the satisfactions of school work. Now there is no question of what we have in mind!

How did we do it--change a fuzzy, vague idea into a precisely expressed thought? By selecting a series of adjectives which clearly describes our ideas. That is exactly the function of adjectives--to describe, limit, or change the meaning of the nouns (mental tools) we use.

Now suppose we wish to expand our ideas--to enrich our meaning. Consider this sentence: "Bob brought the speeding car to a stop." Notice how much more we learn about the idea of Bob stopping the car in this version: "Calmly and skillfully, Bob brought the speeding car to a stop." Do you see that when we use the adverbs calmly and skillfully we have enlarged our understanding by learning how Bob succeeded in stopping the car? Adverbs thus expand the usefulness of verbs (mental tools) as adjectives make more clear the meaning of nouns (mental tools).

Suppose now you wanted to discuss an idea in contrast to something else. Consider this sentence: "The debate concerning the importance of heredity versus environment is a never ending mental game." Since only a subject with more than one view point can be debated, how are we going to convey the two-sided nature of the question in the same sentence? Very simply--by use of the preposition--versus, meaning opposed to or in contrast to. (This use of the word is exactly the same as in your physics experiment (viscosity versus density.)

Although the connective function of prepositions is clearly explained in ENGLISH 2600, I wonder whether you have noticed how many times prepositions not only connect their objects (nouns) to the rest of the sentence, but they also connect the idea in one sentence or paragraph to the following one. Such phrases as "on the other hand," "contrary to," and "instead of" are all expressions by which we "bridge" the topic from one paragraph into a following paragraph.

Do you see now how flexible, yet definite our ideas become by skillful use of the modifiers called adjectives, adverbs, and prepositions? Learn to use with good judgment these mental tools and you will have taken a long step toward effective writing. Good luck--we now undertake to master adjectives, adverbs, and prepositions.

Criteria:

A. To identify without error adjectives, adverbs, prepositions and their objects from their functions in given sentences.
B. To compose original sentences, using the above-listed modifiers as required.
C. To achieve precise expression by writing, as clearly as possible, the material required in Unit 2 for science and math classes.

Essential Vocabulary:

1. noun
2. verb
3. adjective
4. adverb
5. preposition
6. object of a preposition

Criterion Examination:

1. Mastery Test on Unit 2 of ENGLISH 2600.
2. Vocabulary (from all four subjects).
3. Composition.

ENGLISH

UNIT: Measurement of Relationships (How to be Precise in Words)

Criterion Examination

Composition:

On a sheet of scratch paper write a paragraph consisting of 4 or 5 simple sentences describing the viscosimeter you made in Tech Lab.

Be sure each sentence is a complete thought and that 2 or more ideas are not run together in the same sentence.

Underline each adjective you have used once; each adverb, twice. Enclose in a circle each prepositional phrase you have used and underline the preposition itself.

When you have written the most precise description possible copy the paragraph double-spaced on a sheet of composition paper. (This will give you plenty of space to mark your sentences as directed above).

You will be graded on the following criteria:

1) 1) Clear, logical description; and
   2) Correct designation of the modifiers specified above.

ENGLISH

Vocabulary Test - UNIT: Measurement of Realtionships

I. In the space at the left of each statement write T or F, depending on whether the statement is True or False.

____ 1. The mathematical term factoring indicates the reverse of expanding.

____ 2. Difference is to sum as expand is to factor.

____ 3. In mathematics the phrase lowest terms describes a comparison between two numbers in which the denominator is the simplest form.

____ 4. In math the word proportion signifies an imbalance between two quantities.

____ 5. In English a verb is always the person, place, or thing a sentence is talking about.

____ 6. In an English sentence an adjective can be moved about within the sentence much more freely than an adverb can.

____ 7. A product is an answer to a problem in multiplication.

____ 8. In Tech Lab the word tolerance is used to measure the degree of variation from an accepted standard.

____ 9. Clearance means the proportional size of one object in relation to another.

____ 10. In math or science an "ordered Pair" refers to a pair of numbers; the first refers to the input in a functional relation, while the second refers to the output.

____ 11. A preposition is a small word used to connect two independent clauses.

II. In the space at the left of the statement write the letter of the correct choice.

____ 1. All but one of the following terms relate to arithmetical computation:
a) Quotient; b) divisor; c) product; d) flutes.

____ 2. All but one of the following terms refers to the techniques of measurement:
a) calibration; b) locus of points; c) viscosity; d) accuracy.

____ 3. All but one of the following terms is common to both English and math;
a) object of a preposition; b) the preposition versus; c) the noun procedure; d) the noun curve.

____ 4. All but one of the following terms refers to a mathematical function:
a) inputs; b) tapered; c) vertical axis; d) variable quantities.

ACKNOWLEDGEMENTS

The instrumental roles of The Rosenberg Foundation of San Francisco and The Ford Foundation of New York in making the Pre-Technology Program possible is gratefully acknowledged.

Other individuals who graciously contributed their time and made invaluable suggestions are:

Terry Beckley, Sandia Corporation
George Champion, San Francisco State College
Mrs. Jackson Chance, Rosenberg Foundation
Donald Dowdell, Pacific Gas & Electric Co.
Marvin J. Feldman, Ford Foundation
Michael Harris, Ford Foundation
Ida Hoos, University of California
C. James Kain, Lawrence Radiation Laboratory
Robert Mager, Varian Associates
Sidney McGaw, California State Department of Education
Edward J. Meade, Jr., Ford Foundation
Bernard G. Olsen, Lawrence Radiation Laboratory
Robert Pratt, Lockheed Aircraft Corp., Missile and Space Co.
Eugene Wood Smith, Cogswell Polytechnical College
Wesley P. Smith, California State Department of Education
Ralph W. Tyler, Center for Advanced Study in The Behavioral Sciences

The following schools cooperated in the pilot phase of the Pre-Technology Program and contributed to this progress report:

HIGH SCHOOLS

Berkeley High School, Berkeley, California
Cubberley High School, Palo Alto, California
De Anza High School, Richmond, California
Harry Ells High School, Richmond, California
Galileo High School, San Francisco, California
George Washington High School, San Francisco, California
Oakland Technical High School, Oakland, California
Pacific High School, San Leandro, California
Pleasant Hill High School, Pleasant Hill, California
South San Francisco High School, South San Francisco, California

JUNIOR COLLEGES

Chabot College, San Leandro, California
Cogswell Polytechnical College, San Francisco, California
Contra Costa College, San Pablo, California
Diablo Valley College, Concord, California
Foothill College, Los Altos Hills, California
Merritt College, Oakland, California
Laney College, Oakland, California
City College of San Francisco, San Francisco, California
College of San Mateo, San Mateo, California

We sincerely regret that it is impossible to mention all those persons and institutions who have contributed to the success of the Pre-Technology Program. Our appreciation and thanks are extended to them for their help in full knowledge that their anonymity bears no relationship to the value of their service.